F. H. RICHARDSON'S HANDBOOK OF PROJECTION

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The Blue Book of Projection

A Chalmers Publication

RICHARDSON'S HANDBOOK OF PROJECTION

The Blue Book of Projection

FIFTH EDITION

In Two Volumes

VOLUME II

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Volume II

Projectors, Motion Picture

General Instruction applying alike to all makes of projectors will be found on pages 625 to 666

Sprockets in Line

Adjustment of Intermittent Movement

NOTE—In the text you are advised that the intermittent sprocket should have a trifle of circumferential play. This is not really true. With modern projectors there should be none at all, but we feel it is dangerous for any but the experienced projectionist to undertake so fine an adjustment, therefore we have not altered the text from that which applied to projectors years ago, in which an adjustment eliminating such play entirely, usually meant a "freezing" up of the movement.

Adjustment When Cold

Spare Movement

Never Try It

End Play

Worn Intermittent Sprocket Teeth

Heat of Spot

Abuse of Mirror

Screen Surfaces, Characteristics

General Remarks

Speed Indicators

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Characteristics of Screen Surfaces

WHEN we first started work on the Fifth Edition it was realized that such data as were available concerning the various screen surfaces now being used were too old to be of any practical value. We therefore approached Mr. Lloyd A. Jones, of the Research Laboratories of the Eastman Kodak Company, asking if he would consent to make tests of all screen surfaces which might be submitted by manufacturers at our request.

After consultation with the Eastman officials he agreed to do this, with the understanding that the tests were being made primarily for the Fifth Edition of my books, but that they would be available for publication by any trade paper which might wish to use them. The purpose of the tests was to determine the relative reflection powers of each of the surfaces now in use, in every direction up to a fifty degree angle with the plane of the surface of the screen.

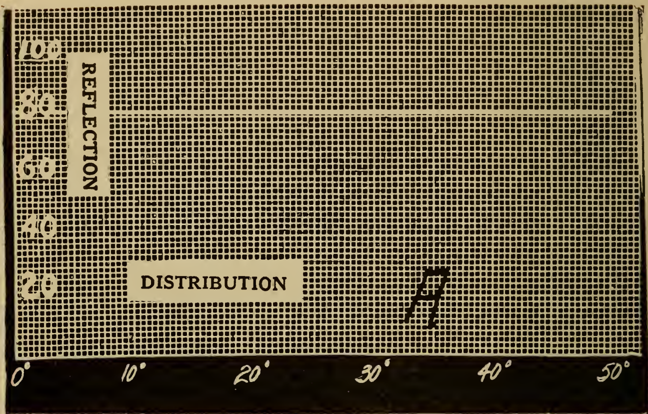
Inasmuch as paint and kalsomine surfaces, much in use for screens, are very familiar to us all, we requested Mr. Jones to test these surfaces also, since they would afford a most excellent medium for comparison of the reflection and diffusion of other sufaces.

The purpose of all this is to protect the projectionist and exhibitor by enabling them to have thoroughly reliable data concerning the characteristics of the various screen surfaces, and thus to be able to select the one which will have maximum efficiency in any given theatre auditorium. All screen manufacturers were invited to send samples of their screen surfaces for test.

Important—Similar tests of new surfaces, provided they be sponsored by reasonably responsible individuals or concerns, may be had at any time by forwarding samples twenty-four inches square, stamped on the back with the trade name under which it will be marketed, to the author of this book, care Moving Picture World, 516 Fifth Avenue, New York City.

These tests of course take no notice of the general construction of the screen, or of the probable tendency of its surface to deteriorate, discolor or become dull. Those various things must be judged by the buyer, however **we strongly advise projectionists to refuse to recommend for purchase, and exhibitors and theatre managers to refuse to purchase any screen which has not been submitted for test, and the results of the test made public.**

Note: It will of course, in the nature of things, be impossible to keep right up to date in the matter of publication of the tests made of new surfaces in this book, but **the result of any tests of new surfaces made will be published in the**



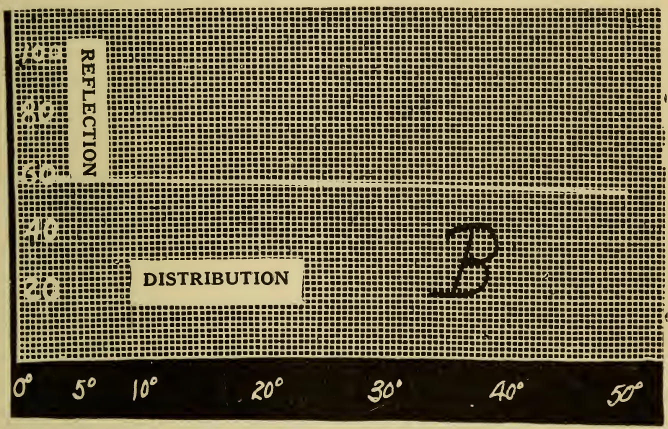
SURFACE A

projection department of the Moving Picture World, and possibly (if they care to do so) in other trade papers, and such additional data may be clipped out and tipped into this book at the proper place.

Reflective Powers of Screen Surfaces.—The general idea is to enable reputable screen manufacturers to supply to you, and if necessary to force other manufacturers to supply reliable data on the reflection powers and characteristics of the surfaces they propose to sell to you. By the use of this data the exhibitor or projectionist is enabled to make intelligent selection of the screen surface which will have the highest reflective value coupled with the distribution best suited to his auditorium, which two factors form the points of basic importance in screen surfaces. Having determined which surfaces will give you best general results, it then is merely a matter of initial cost price, probable length of time the surface and its backing will give efficient service, and possibility of renewing the surface without prohibitive cost.

On behalf of exhibitors and projectionists, as well as on our own behalf, we wish to most cordially thank the Eastman Kodak Company and Lloyd A. Jones for this splendid contribution to the industry.

Reflection Factor Explained—The ability of a surface to reflect light which falls upon it is expressed in terms of its **reflection factor.** This is defined rigidly as "the ratio of the luminous flux reflected by the surface to the luminous flux incident upon it." The brightness of a motion picture screen as viewed from any particular point is directly proportional to that **particular** value of reflection factor **as measured in the direction of observation.** In the practical determination of the reflection factor it is customary to use as a reference standard a surface whose reflecting power is precisely known, since such procedure is much easier and simpler than the direct measurement of the reflection factor in absolute terms. The

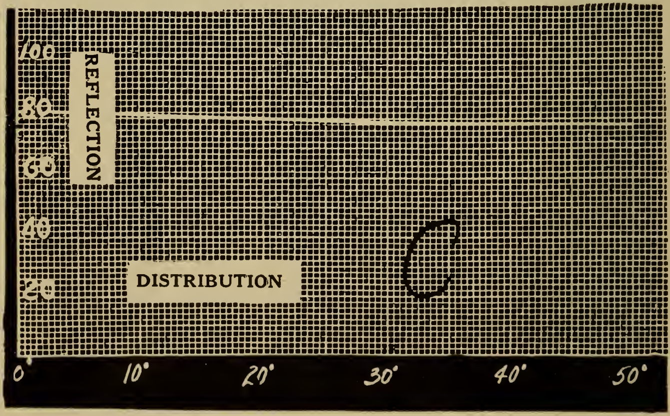


SURFACE B

surface most commonly used for this purpose is that obtained by scraping a block of magnesium carbonate so as to obtain a perfectly smooth textureless surface. The reflection factor of such a surface has been measured with great care by a number of different observers in the national standardizing bureaus and in other research laboratories. A very general agreement upon a value of 98 per cent for such a surface has been reached. This surface was therefore adopted as a reference standard in measuring the reflection factors of the screen surfaces reported herewith. The value quoted, 98 per cent, refers to the total reflection factor of this surface.

The distribution of the reflected light from the surface is not perfectly uniform, hence the reflection factor determined by measuring with light incident normal to the surface and with normal observation must be slightly higher than the value of total reflection factor. It seems satisfactory, therefore, to assume a value of 100 per cent for this reference surface under the above specified conditions of illumination and observation.

All of the values reported in the following tables are therefore on a basis of this reference surface considered as having a reflection factor of 100 per cent when illuminated with light incident normal to its surface and when also observed normally, that is with the line of sight perpendicular to the surface. In table 1 is given a complete list of the surfaces examined. The first seven of these are surfaces prepared in the laboratory as typical of various well known materials. It should be understood that the reflection factors of other surfaces prepared by using similar materials may vary somewhat from the values given due to variations in the composition of paints designated by similar qualitative descriptions and in the technique of the preparation. The values are given simply as typical of such surfaces in general. In the same table will be found data relative to the manufacturer, trade name, texture, and color of the various commercial screen surfaces tested. The words used as descriptive of texture and color are necessarily qualitative. It should be clearly understood that the terms describing texture and color are very general in nature as no precise quantitative measurements of these characteristics were made.



SURFACE C

In table 2 are given all of the data relative to the surfaces, both experimental and commercial. The number in the first column is merely the identification number of the surface. The values in each of the following columns is that of **reflection factor** as measured at the **angle** indicated at the top of the column. In making these measurements a beam of collimated light was projected normally onto the surface being examined, that is the axis of the projection system was perpendicular to the screen surface. A brightness measurement was then made with the observing photometer set at the various angles indicated at the top of the columns in table 2, that is, the angle between the optical axis of the photometer and a line perpendicular to the screen surface as was indicated by the angular values.

For further details relative to methods of measuring distribution of reflected light the reader is referred to the original paper on the subject (Proceedings of Society of Motion Picture Engineers No. 11, page 59, and Handbook of Projection, Fourth Edition, page 260). It will be noted that the value given for surface No. 1, magnesium carbonate, at 0° is 100%. This value of course is taken arbitrarily as the unit in which to express the values for other surfaces and at other angles. It should also be noted that for this same surface the reflection factor at 5° and 10° is also 100% decreasing to 97% at 50°. It is evident therefore that the reflection factor of this surface is practically independent of the angle and hence the brightness of such a surface is independent of the angle of observation. It will be noted that many of the surfaces at 0° have reflection factors greater than 100% This means of course that when observed normally, that is along the axis of the incident light beam, they will appear brighter than the magnesium carbonate surface. For instance material No. 8, which has a value of 414% at 0° will when viewed along the axis of the illuminating beam appear over four times as bright as the carbonate surface.

The reflection factor for this surface at 30° however has fallen to 73% which is appreciably less than that of magnesium carbonate, and at 50° its reflection factor is only 17% showing that a picture projected upon such a surface and observed at an angle of 50° from the axis of projection will have a brightness approximately 1/25 (17/414) as great as along the axis of projection and approximately 1/6 as bright as the same picture if projected onto a screen having reflection characteristics the same as those of magnesium carbonate. It is perfectly obvious from a consideration of these facts that the choice of a screen surface for any particular theatre will depend vitally upon the lateral distribution of the seats.

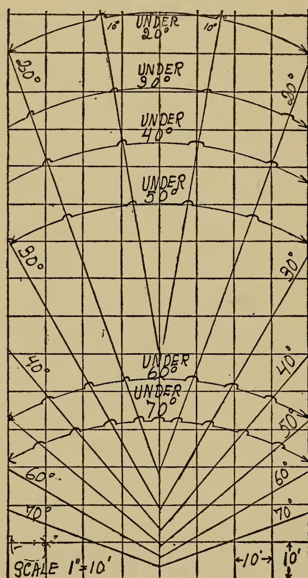


Figure 147q

And now let us see exactly what that means. In Fig. 147q we have the representation of an auditorium 80 feet wide by 150 feet front to back. The individual can select the side lines which fiit the width of his own theatre. Each of the small squares is 10 feet each way.

In table No. 1 we see that the angle of highest efficiency lies either within or very near to 20 degree lines for ordinary commercial screens, and that beyond 30 degrees all the surfaces except those surfaces having a very low reflective and high diffusive power) fall off very rapidly, none of them standing much above 50 per cent. at 50 degrees angle. We may therefore conclude that for all the high reflective surfaces tested the range of efficiency lies well within the 50 degree angle, and it must be considered that beyond 30 degrees the difference between screen brilliancy in different sections of the house is such that it is apt to be noted by patrons, though this may be to some extent balanced by the preference some patrons have for a more or less brilliant picture.

Applyiing Fig. 147q let us suppose the exhibitor to have a house 40 feet wide by 70 feet deep. Following the 20 degree angle lines through the auditorium we see that considering a single point at the center of the screen at 20 feet from the screen, a space considerably less than 20 feet wide, or less than half the width of the house, falls within that angle, and even the 40 degree angle does not take in the entire width at 20 feet from the screen. At 30 feet from the screen the 30 degree angle does not take in the entire width of the house, whereas the 20 degree angle only includes a little more than 20 feet of its width.

But we consider only a point at the center of the screen. whereas the screen is 16 or more feet wide, so that the angle will include 8 feet more space on one side, but the patron seated on that side will be just that much worse off insofar as has to do with the other half of the screen.

Our purpose, however, is to indicate how Fig. 147q should be applied in practice, rather than to draw conclusions, since we shall, later, give you the conclusions arrived at by those making the test. We give you Fig. 147q and we give you the tables showing the characteristics of the various surfaces. The rest is up to you, insofar as application of the data to your own local condition be concerned.

Remember that each one of the horizontal lines in Fig. 76 represents 10 feet of front to back depth, while e ach perpendicular line represents 10 feet of auditorium width.

The makers of the test draw their own conclusions, which same we shall present verbatim, and with no more comment than may be necessary to make the meaning clear.

CONCLUSIONS ARRIVED AT.—In order to facilitate the examination of the data, it will be well to separate them into their respective classes. After careful consideration of the characteristics of the screen and of the requirements of use in practice.

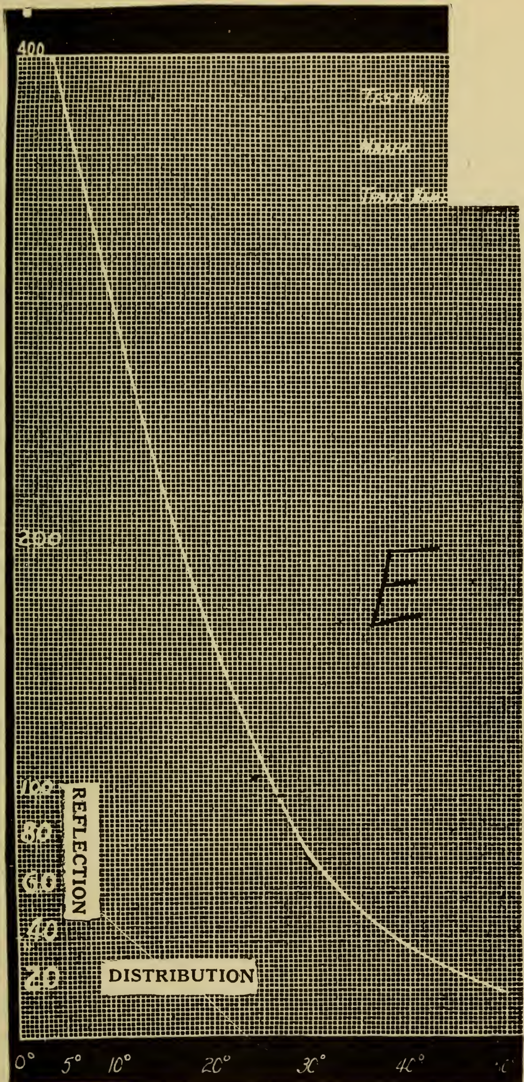
An examination of the reflection characteristics of the screens examined and tested shows that they may be roughly grouped into three general classes:

A, specular
B, semi-specular
C, diffuse

Class A includes all of those surfaces which reflect a large proportion of the incident light within a relatively narrow angle. Class C includes those screens which have a high diffusing power and therefore the reflected light is distributed approximately uniformly over a wide angle. Class B contains those screens which are intermediate between the extremes represented by class A and C. It should be emphasized however that the line of demarkation between these three classes is not definite. The classification is somewhat arbitrary and is made only for purposes of practical convenience.

In examining and considering the data here tabulated **the exhibitor and projectionist should remember that two items only are considered, viz.: the reflecting power of the surface and its relative reflection at varying angles,** and that while these two things are of first importance, still there are other very desirable physical characteristics to be considered when the final selection of a screen is to be made. It may be found, for instance, that two or more surfaces are equally efficient for a certain auditorium, insofar as concerns reflective power and evenness of light distribution, but that one of them is found to have other characteristics superior to its competitors, such as a more substantial foundation (cloth backing) or the mounting or guarantee given with it. In such a case the final selection would of course be made on these latter points, reflection and distribution being equal.

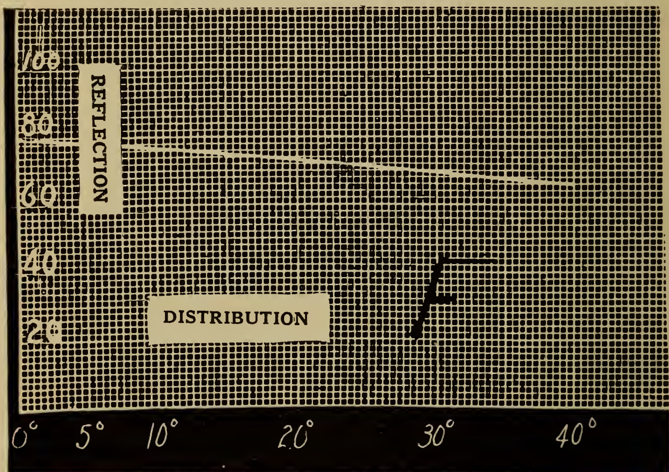
In table 3 are tabulated the screen surfaces which have been classified as of specular type, class A. For convenience in analyzing the characteristics and in order to show the essential peculiarities of screen performance under various conditions the values of "ratio" and "R" have been computed for angles of 20°, 30°, 40°, and 50° as indicated at the top of the tabulation. The value of "ratio" is obtained by dividing the reflection factor at 0° by the reflection factor at the angle as indicated at the top of the table. For instance in the case of surface No. 8 the reflection factor at 0° (see table 2), is 414 while that at 20° is 153. The ratio of 414 to 153 is 2.7


400
200
100
80
60
40
20
REFLECTION
DISTRIBUTION
E
0°
5°
10°
20°
30°
40°

SURFACE E

as shown in the ratio column under 20°, table 3. Likewise the reflection factor for this screen at 30° is 71. Dividing 414 by 71 we obtain 5.83 as shown for that screen in the 30° column of table 3.

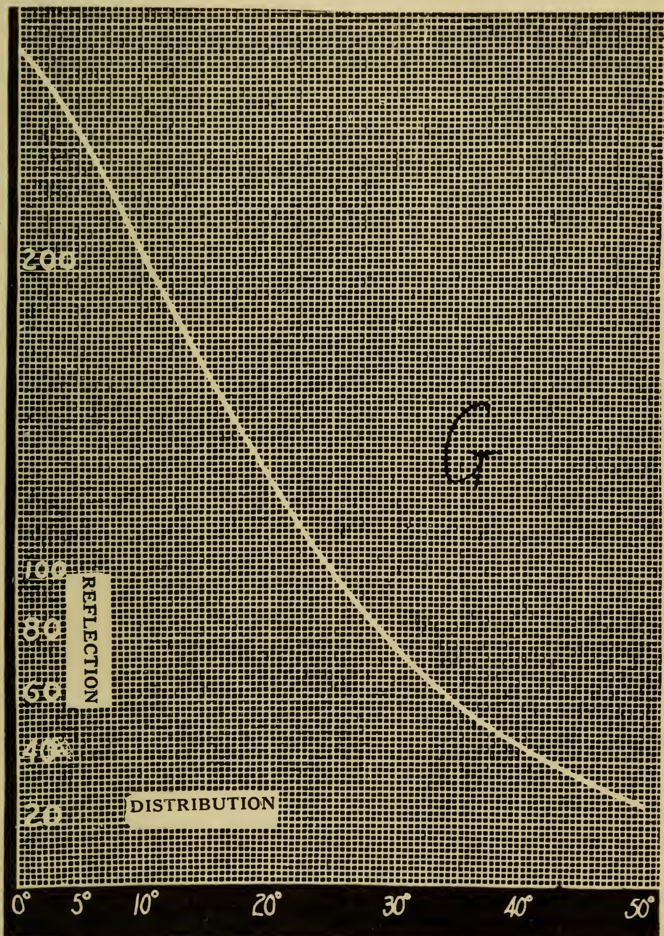
This value then in all cases gives the ratio of the screen brightness when viewed along the axis of projection to the brightness as observed at the angle indicated at the top of the various columns. These numbers are valuable in determining how great a difference in picture brightness exists between the seats along the center of the auditorium and those at the extreme sides. For instance suppose that in the par-



SURFACE F

ticular theatre under consideration the extreme angle of view is 40°. Now if screen No. 12 were installed in this theatre the picture as seen from the seats at the maximum angle would have a brightness only 1/7 as great as when the picture is observed from a seat on the center line of the auditorium.

The values tabulated in the columns designated as **R** give the mean (or average) value of reflection factor within the angle as indicated at the top of the column. Thus for screen No. 8 the average reflection factor for all angles out to 20° is 306. Now since it is desirable that there be as little change of brightness with angle of observation as possible and that the average brightness of the picture shall be as great as possible, it follows that the screen giving a minimum value



SURFACE G

of ratio and a maximum value of **R** is the most desirable from the standpoint of distribution of reflected light.

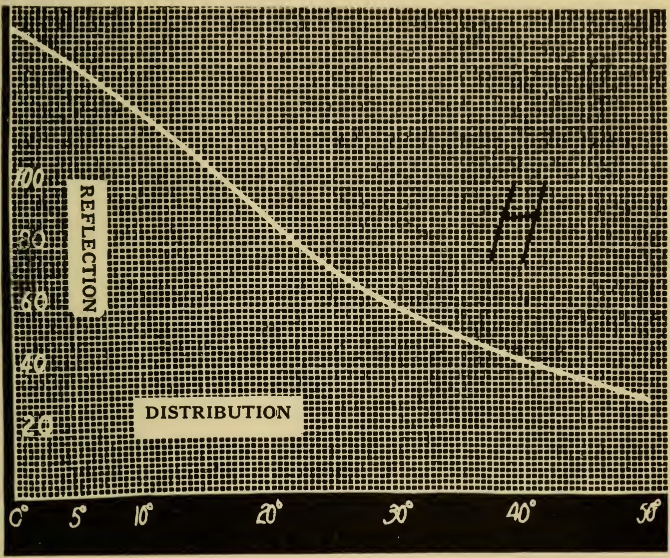
In table 4 are tabulated the values of **ratio** and **R** for the screens classified as semi-specular, class B. It should be noted that the values of ratio are in general much lower for this class than in the case of the specular screens (class A). Likewise the values of **R,** the mean reflection factor, for various angular limits are lower in general.

In table 5 are given the values relating to screens of the diffuse type, class C. The very low values of **ratio** for the screens of this class indicate that the screen brightness varies but little with angle of observation. Unfortunately the values of average reflection factor, **R,** are also much lower in general than for the screens of the semi-specular and specular types. In theatres where the maximum angle of observation is great, however, it is necessary to use screens of the diffuse type in order to avoid obtaining a much more brilliant picture when observation is along the axis of projection than when the picture is observed from the side seats.

The use of a specular type screen in a theatre will necssarily result in a variation of brightness across the screen when observed from a point relatively near the front of the house. It is therefore necessary to use a screen of the diffuse or semi-diffuse type in order to obtain a picture of uniform brightness.

The separation of the various screen surfaces into classes facilitates to a certain extent the analysis of the results from the standpoint of their practical application. The screens classified as specular in type, class A, are suitable in general for use in theatres where the maximum angle of observation is relatively small, less than 25° or 30°. The surfaces classified as semi-specular, class B, are suitable for use in an auditorium where the maximum angle is somewhat greater than in the previous case. For all cases where the maximum angle of observation is greater than 40° a screen of class C type should be chosen.

From a careful consideration of the subject it seems that the value of the ratio of the reflection factor measured at normal observation to that measured at maximum angle of observation in any particular installation serves as the most logical criterion from which to select the most suitable screen in any case. This value represents the ratio of brightness of the screen as observed by a person in the center of the auditorium to that of the brightness observed by a person occupying a seat at the side and near the front. By keeping this



SURFACE H

ratio below a certain limiting value satisfactory picture brightness may be obtained for all observers. This factor alone, however, is not sufficient for the classification of screens according to their relative merits. The highest average reflection factor within the required angle from the normal will necessitate the least energy expenditure in the projecting system to produce a specified screen brightness. The values of **ratio** and **R** tabulated in tables 3, 4, and 5 are therefore of direct applicability, in deciding upon the suitability of any screen for use in a theatre where the angular distribution of the seating capacity is known.

Now it seems reasonable to demand that the ratio of the brightness on the axis to that at the extreme angle of observation shall not be greater than 4.0. This value is decided upon after consideration not only of the variation in brightness as observed from various points in the auditorium, but also from

TABLE No. 1

No.	Class	Manufacturer	Trade Name	Texture	Color
1	C		Magnesium carbonate	Smooth	White
2	C	Lockwood	Cotton sheeting	Fine Grain	White
3	C		2 coats mill white paint on card-board	Smooth	White
4	C		Calandered cardboard	Smooth	White
5	C		Plaster wall surface Kalsomine	Smooth	White
6	B		Wallboard with 2 coats gold leaf bronze paint	Smooth	Metallic yellow
7	B		Wallboard with 2 coats aluminum paint	Smooth	Metallic white
8	A	The L. J. Gardiner Co.	Gardiner Velvet Gold Fibre		
			Screen grade No. 1	Pebbled	Metallic yellow
9	A	"	Screen grade No. 3	Coarse grain	Metallic yellow
10	A	"	Screen grade No. 4	Smooth	Metallic white
11	C	"	Screen grade No. 5	Fine grain	White
			Superlite	Pebbled	Metallic white
12	A	C. S. Wertsner & Son	Keystone	Fine grain	Metallic white
13	A	"	Special silver	Pebbled	Metallic white
14	B	"	Peerless	Coarse grain	Metallic white
15	B	Da-Lite Screen & Scenic Co.	Golden Fleece	Coarse grain	Metallic yellow
16	B	"	Crystal White	Fine grain	White
17	C	"	Mazdalite	Coarse grain	Metallic white
18	A	"	Simplicity	Smooth	Metallic white
19	B	Walter G. Preddey	Master White Tone	Smooth	White
20	C	The National Screen Co.	Master Glass Bead No. 5	Medium beaded	White
21	A	"	Master Glass Bead No. 7	Small beaded	White
22	B	"	Mirrortone	Coarse grain	Metallic white
23	A	Raven Screen Corp.	Silvertone	Coarse grain	Metallic white
24	B	"	Singletone	Fine grain	White
25	C	"	Mazda Haftone	Fine grain	White
26	C	"	Haftone	Fine grain	White
27	C	"	Painted	Fine grain	White
28	C	"	DeLuxe Special Matte	Pebbled	Metallic white
				Pebbled	Metallic white
29	A	Minusa Cine Screen Co.			
30	A	"	DeLuxe Special Ingrain	Metallic white	Metallic white
31	A	"	DeLuxe Special Pebbled	Pebbled	Metallic white
32	A	"	De Luxe Special Smooth	Smooth	Metallic white
33	C	Acme Film Studios	Acme F	Rough matte surface	White
34	A	"	Acme WB	Glass bead surface	White
35	A	"	Acme A	Texture not given	Metallic white
36	A	"	Acme C	Texture not given	Metallic white
37	A	"	Acme M	Texture not given	Metallic yellow

a consideration of the fact that from a given point of observation the screen may appear of unequal brightness over its area. The danger of this inequality being serious increases rapidly as the value of the above mentioned ratio in reflecting

TABLE No. 2

No.	0 deg.	5 deg.	10 deg.	20 deg.	30 deg.	40 deg.	50 deg.
1	100	100	100	99	98	98	97
2	61	61	60	59	58	57	56
3	80	79	78	77	76	74	70
4	113	109	106	94	83	80	79
5	82	82	82	81	81	81	81
6	132	125	115	88	66	50	37
7	163	150	134	93	61	43	31
8	414	361	295	153	71	32	17
9	436	385	319	161	73	34	20
10	427	380	300	163	73	36	18
11	80	79	77	74	69	68	68
12	301	281	240	140	76	43	23
13	274	255	223	132	73	43	24
14	271	244	205	132	77	45	26
15	220	200	173	115	68	40	24
16	357	315	264	149	73	38	21
17	76	75	74	73	72	71	69
18	338	305	252	129	75	42	22
19	151	139	125	89	60	43	30
20	78	77	77	76	75	74	73
21	291	273	204	83	55	48	47
22	217	205	167	89	63	55	51
23	357	328	280	145	66	36	21
24	228	215	194	140	83	54	35
25	80	79	78	76	74	72	69
26	86	86	85	83	82	80	76
27	82	80	79	76	72	69	66
28	72	71	70	68	66	64	63
29	450	417	324	150	67	35	22
30	348	280	210	105	58	31	18
31	319	281	231	130	69	37	21
32	436	347	269	127	60	43	20
33	84	84	78	76	76	75	75
34	280	242	150	67	48	39	37
35	294	284	242	148	71.5	34	19.6
36	409	394	342	186	82	37.4	19.6
37	309	298	268	163	77.2	38.6	21

powers increases. **Assuming now that we adopt the value of 4** as the limiting value of the reflecting power ratio, it is possible from the figures in Tables 3, 4 and 5 to choose the best screen for any one of the cases considered. For instance, assuming that the maximum angle of observation is 20°, it will be noted that all values in the under 20° ratio column of Table 3 are less than 4. Therefore from the standpoint of distribution any one of the screens in Class A will be satisfactory for use where the angle of observation does not exceed 20°. In order now to obtain the maximum results in screen brightness for any given current consumption it is only necessary to choose that screen, or screens, which shows the highest value in the column marked R.

Next assuming a maximum angle of 30° we find that only two screens of class A have a ratio of normal to extreme (30°) reflection factor which is less than 4.0. Hence on the basis of our assumptions only two screens of class A are suitable for use in an auditorium where the maximum angle of observation is 30°. Turning to class B however we find that all of the screens have a ratio at 30°, less than 4.0. Again the screen having the highest average reflection factor, R, will give the most brilliant picture for a given energy consumption. (Author's note: This average reflection factor is found by adding the reflector factor for the 0, 5, 10, 15, 20 and 30 degree angles and dividing by 6).

TABLE No. 3

CLASS A

Surface	20 deg.		30 deg.		40 deg.		50 deg.	
No.	Ratio	R	Ratio	R	Ratio	R	Ratio	R
8	2.70	306	5.83	259	12.9	221	24.3	192
9	2.70	325	5.97	275	12.8	235	21.8	204
10	2.62	318	5.85	269	11.9	230	23.7	200
12	2.15	241	3.96	208	7.00	180	13.1	158
13	2.07	221	3.75	191	6.37	167	11.4	146
16	2.39	271	4.89	232	9.38	199	17.0	174
18	2.62	256	4.50	220	8.04	190	15.4	166
21	3.51	213	5.28	181	6.06	159	6.19	143
23	2.46	278	5.41	235	9.92	202	17.0	176
29	3.00	337	6.72	282	12.8	241	20.2	209
30	3.31	236	6.00	200	11.2	172	19.4	150
31	2.47	240	4.62	206	8.62	178	15.2	156
32	3.43	295	7.26	248	10.1	214	21.8	186
34	4.20	185	5.85	157	7.20	138	7.57	123
35	1.99	242	4.11	208	8.65	179	15.00	156
36	2.20	333	4.98	283	10.90	242	20.80	210
37	1.90	259	4.00	223	8.00	192	14.70	168

Considering now a maximum observational angle of 40° we find that no screens of class A fulfill the requirement of a ratio less than 4.0. In class B, four of the screens however are suitable and all of the screens of class C fall within the specified limit.

Following the same reasoning if the maximum angle of observation is 50° then only two screens of class B are suitable, while all of those of class C fulfill the requirement. There is little point, however, to discussing the requirements of a 50° maximum angle of observation since the geometrical distortion at 50° or greater is so enormous as to render practically useless seats placed at such angles from the screen.

The accompanying cuts, lettered from A to H inclusive, offer plain and somewhat startling proof of the necessity for careful selection of a screen surface to "fit" the auditorium.

Surfaces A, B and C are respectively plaster wall, cloth (Lockwood sheeting) and white pebbled wall paper.

In reading performance curves such as these you must remember that up and down represents reflection power at the various angles at which the screen surface is viewed, 100 presumably representing the reflection powers of the surface used for comparison in the tests, viz.: Magnesium Carbonate.

Surface A, kalsomine, page 484 is to all intents and purposes a perfect diffusing surface. With it the screen will look just as bright at a fifty degree angle as at a position straight in front of it—0° angle. True there is just the least bit of drop in the "curve" line, but it is so slight as to be negligible. You will also observe that it has a reflection power of a little more than 80% when one stands straight in front of it, which drops to only a bit below 80% at a 50 degree angle. EXCEPT FOR CLOTH (Surface B) you will find that all surfaces having high diffusing power have pretty close to 80% for their straight-in-front reflection power. Cloth, B, Page 485. has a bit more than 60% for its straight-in-front reflection power, and drops to a bit less than that figure at 50° angle —that is to say, when you move to the side of the auditorium until you view the screen surface at an angle of 50°.

Kalsomine, therefore, is a much better screen surface than cloth, because it not only has a much higher power of reflection, but also a somewhat better diffusing power than has cloth, assuming both surfaces to be in good condition as to cleanliness, of course.

TABLE No. 4

CLASS B

Surface No.	20 deg. Ratio	R	30 deg. Ratio	R	40 deg. Ratio	R	50 deg. Ratio	R
6	1.06	115	1.26	105	1.38	96	1.51	87.6
7	1.21	135	1.36	120	1.52	107	1.72	95.0
14	2.05	213	3.50	186	6.02	162	10.4	143
15	1.91	177	3.24	155	4.78	136	9.16	120
19	1.70	126	2.52	113	3.51	101	5.03	91.0
22	2.44	170	3.44	148	3.94	133	4.25	121
24	1.63	194	2.74	172	4.22	152	6.52	136

Surface C is pebbled wall paper, P. 486 you will observe has essentially the same reflection power as kalsomine, but is not quite so perfect a diffusing surface.

Turning now to commercial screen surfaces, F and G, Pages 490, 491 are screen surfaces made and marketed by the same manufacturer.

Observe their enormously different characteristics. Surface E has a straight-in-front reflection power fully TWENTY TIMES AS GREAT as it has when viewed at a 50° angle. This means that the patron seated straight in front of such screen will see fully twenty times as brilliant a picture as will the one seated in the front side seat of a house wide enough to give that seat a 50° angle to the screen. The installation of such a surface in a wide theatre would be nothing less than a catastrophe. The surface is only adapted for use in a very narrow, long auditorium, and it is even questionable if it is adapted to theatre use at all, because even at a ten degree viewing angle the fade away is quite heavy, while at 20° the screen is not even half as brilliant as it was at straight-in-front position.

TABLE No. 5

CLASS C

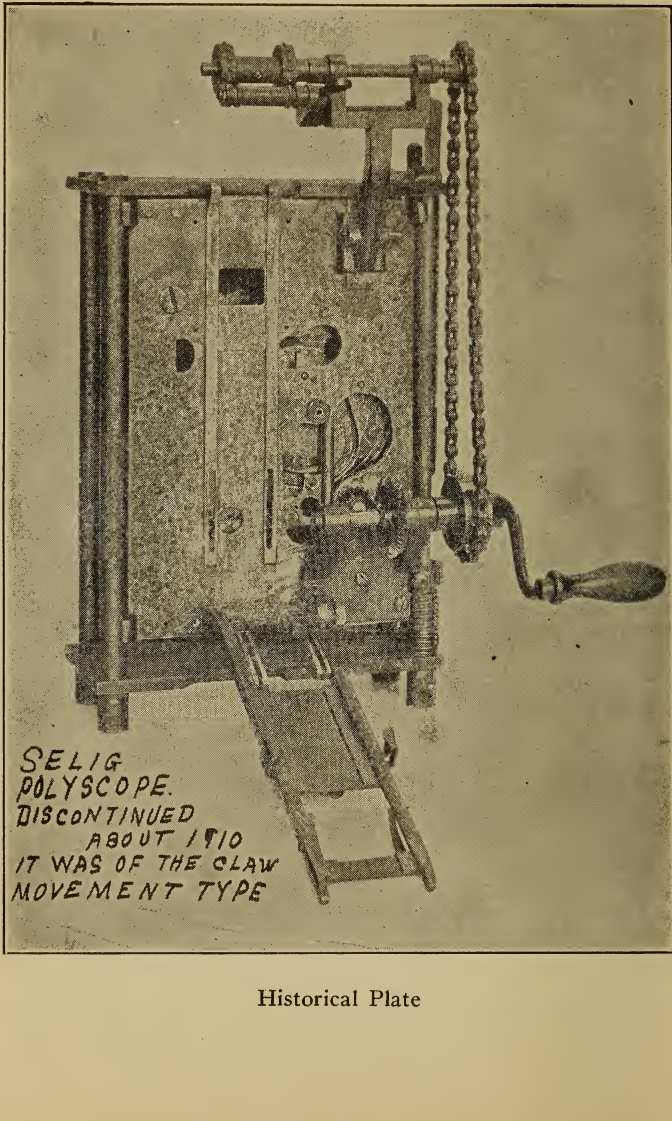
Surface No.	20 deg. Ratio	R	30 deg. Ratio	R	40 deg. Ratio	R	50 deg. Ratio	R
1	1.01	99.8	1.02	99.4	1.02	99.2	1.03	99.0
2	1.03	60.2	1.05	59.8	1.07	59.3	1.09	58.9
3	1.02	78.5	1.03	78.0	1.04	77.3	1.05	76.3
4	1.07	105	1.12	101	1.16	97.5	1.19	94.9
5	1.01	81.8	1.01	81.6	1.01	81.5	1.01	81.4
11	1.08	77.5	1.16	75.8	1.18	74.5	1.18	73.7
17	1.04	74.5	1.06	74.0	1.07	73.5	1.10	72.9
20	1.03	77.0	1.04	76.6	1.05	76.2	1.07	75.7
25	1.05	78.2	1.08	77.4	1.11	76.5	1.16	75.4
26	1.04	85.0	1.05	84.0	1.07	83.0	1.13	82.0
27	1.08	79.2	1.14	77.8	1.19	76.3	1.24	75.0
28	1.06	70.2	1.09	69.4	1.12	68.5	1.14	67.7
33	1.10	83	1.10	82	1.12	80	1.12	79

On the other hand surface F, made by the same company, is an excellent surface for a wide auditorium, since it has a straight-in-front reflection of 80%, and at 50° (for some reason Mr. Jones only carried this one out to 40°, but presumably the loss would continue to 50% in about the same proportion) it has not dropped enough to be seriously objectionable.

Surfaces G and H are examples of screens which have characteristics which entitle them to serious consideration for use in theatres of medium width and considerable depth. Surface G has reflective power equal to plaster up to a 30° viewing angle, and a reflection power many times that of plaster from straight-in-front. There is a pretty heavy fade away, yes, but one must see what the possible viewing angles of his seating will be and decide whether that fade-away will be sufficiently objectionable to offset the advantage of high reflection power within the more narrow angles.

Surface H is another example of a surface which has higher reflection power than plaster (I use plaster as a comparison surface, because we all know about what the plaster will do in the matter of light reflection) above a 22° angle, sinks to that of cloth at 30°, and is quite poor in reflection powers below the 30° viewing angle. It would appear about six times as bright at a straight-in-front position as it would at a 50° angle.

These surfaces are all included in the accompanying tables.



Historical Plate

Current Rectification

ONLY a small percentage of the theatres of the United States and Canada have an available direct current supply. The rest have A. C. supply only. We are not sufficiently conversant with the situation in this respect with regard to other countries in which this book is used to attempt an approximation of the percentage of theatres having A. C. supply only, but no theatres anywhere have a current supply the voltage of which is suitable for use at the arc.

It is a well-known fact that an alternating current projection arc is not only very much more difficult to handle, but also is likely to be more or less noisy (though special A. C. carbons have largely reduced the element of noise) also that very nearly double the amperage is required at the arc to secure an effect equal to a direct current projection arc. In other words, to equal the effect of a 40-ampere D. C. projection arc, an A. C. arc operating at about 80 amperes would be necessary. Why this is so is explained on Page 392.

Due to these facts, the almost universal modern practice in large theatres, and the very general practice in smaller theatres, is to "rectify" the alternating current supply (change it to D. C. and to arc voltage) either by means of a motor-generator set or a mercury arc rectifier, either of which receives alternating current from the line and delivers direct current at the arc, in most cases at arc voltage. These machines have been brought to such a state of perfection with regard to mechanical construction, efficiency, operation and ease of manipulation, that there is now absolutely no legitimate excuse for the continued use of alternating current at the projection arc. True, the exhibitor may offer in excuse the fact that the installation cost of the motor-generator or mercury arc rectifier, plus the item of deterioration, is a considerable sum, but this in fact is no excuse at all, because he will get all that and very much more besides back in increased patronage of the box office by reason of improved screen results.

This latter is, of course, in a few instances modified by the fact that there is an occasional projectionist who is sufficiently expert in the handling of the alternating current arc to produce results very nearly equal to the direct current arc. This, however, does not hold good to any considerable extent, and broadly speaking does not in the least invalidate our former statement.

The Projection Department of Moving Picture World and the author of this work unqualifiedly recommend the installation of either a motor generator set, or a mercury arc rectifier, with the notation that modern practice favors the motor generator set as against the mercury arc rectifier, because of the fact that the motor generator is a very much more flexible machine. The motor generator may be temporarily overloaded by as much as 100 per cent., though, of course, such an overload could only be maintained for a moment or two—sufficient time, however, for change-over—whereas the mercury arc rectifier cannot be overloaded to any considerable extent; also the motor generator may be had in any desired capacity, whereas the mercury arc rectifier is not made in anything exceeding 50 amperes capacity.

Let it be clearly understood that we do not recommend the overloading of a motor generator by 100 per cent., even for a short time, but such a machine should carry a 50 or even a 75 per cent. overload for as much as three minutes, with reasonable frequency, without sustaining injury.

MOTOR GENERATORS.—In the ordinary acceptance of the term as applied to projection, the motor generator is nothing more or less than an alternating current motor, of suitable voltage, cycle and phase to operate on the available supply, direct coupled to a direct current dynamo, the latter, in latest and best practice, being of the constant current type, i. e., wound to deliver an approximately steady amperage at considerable variation in arc voltage.

In fact the latter phase of the matter has been carried to such an extent that arc voltage may be doubled without appreciably altering the amperage. The latest practice is the motor generator, the dynamo of which is so wound that when it is "pulling" one projection arc, a second can be cut in series with the first, whereupon the voltage of the dynamo doubles, the amperage remaining constant.

The advantage of this type is that with a minimum effort on the part of the projectionist the change-over may be made without the slightest evidence of the act on the screen. This is by reason of the fact that with the arcs operating in series, in the very nature of things both of them must and will have precisely the same amperage, and if the adjustment of both, as regards distance from collector lens and angle of crater, be the same, and the optical train be identical, the screen illumination from each must and will have precisely the same value.

Another plan which has merit is that of the motor generator having a 70-volt dynamo using ballast resistance to reduce the generator voltage to arc voltage. The waste involved is very slight and the plan has its advantages.

D. C. to D. C. SETS.—There is a special motor generator set made, known as the "D. C. to D. C. motor generator," which operates, in effect, merely to reduce the voltage. (See Page 521.)

GENERAL INSTRUCTIONS ON MOTOR GENERATORS.—In the interest of economy of space we shall give certain instructions which apply alike to all motor generators. To incorporate these in the matter covering each individual machine would merely be a reiteration of the same thing several times.

WARNING.—Exhibitors often complain to the author that their motor generator set is not as efficient as was claimed by the manufacturer. This may very easily be true without any fault on the part of the maker, for while a machine in perfect condition may show high efficiency, after a few months of unintelligent handling, or abuse, it may show something very different. Factory efficiency tests are made with machines in the very pink of condition. They naturally show very much higher than after a few months under the care of a careless or slovenly attendant, or one who knows very little and perhaps cares less beyond how to start and stop them, and to put fresh oil in the oil wells "once in a while" Loose connections, dirty brushes and roughened commutators do **not** make for efficiency.

It occurs, too, that the projectionist will permit his arc, which should operate at a certain length and voltage, to open to a length considerably greater with probably 10 volts more drop. This, on a constant current generator, means an increase of current consumption of about 15 per cent. and a corresponding drop in efficiency without any gain on the screen.

GENERAL INSTRUCTIONS NO. 1, LOCATION.—Several things must be given very careful attention when the location for a motor generator is considered.

If it be practical it is decidedly better to locate the motor generator in a room directly adjoining and connecting with the projection room. If this is not a practical thing to do, then it may even be located within the projection room itself.

A basement location is, for several reasons, objectionable, and if the basement be damp and dark it should not be considered at all. Where there is dampness, the insulation of the wires will absorb more or less moisture while the machine is idle. This moisture will be expelled rapidly when the machine warms up, and this, many times repeated, is more than likely to do harm. It may, in time, entirely ruin the armature and field coils, which would compel the rebuilding of the entire electrical part of the machine. Another serious objection to this location is that in case anything goes wrong it takes a very much longer time to investigate and make necessary adjustments or repairs than would be necessary were the machine located either in the projection room, or in a room adjoining and connecting therewith. Then, too, a dark basement (or other location) compels the making of all repairs and performing other necessary operations entirely by artificial light, which is to some extent objectionable. **Another very, very serious** objection with many basements is that when the furnace is going there will be more or less coal and ash dust in the air, which is bound to get into the machine, and in course of time do irreparable injury thereto.

But after all, the most serious objection of all is the fact that the machine will be more or less inaccessible to the projectionist and will therefore be neglected. It most emphatically will not receive the daily attention it ought to receive. Common sense should tell anyone that a machine which is conveniently located and easily accessible will receive more and better attention than if it be located at a distance and a more or less inaccessible place. Common sense should also tell anyone that lack of necessary attention means increased deterioration in the machine itself. In other words the machine which has proper attention will operate with greater efficiency and last much longer than one which does not receive proper attention.

The only legitimate objection to locating machines of this kind in or adjoining the projection room lies in the possibility of vibration and noise, or in the weakness of the floor. We may, however, dispose of the latter by saying that any floor too weak to carry a machine of this kind is entirely unfit to be the floor of a projection room. As to the matter of vibration, it has, to all intents and purposes, been eliminated in modern machines of this type and such vibrations as remains can be entirely absorbed by means of a felt, cork or rubber mat, as per instructions under "Installation."

GENERAL INSTRUCTIONS NO. 2—INSTALLATION.— Upon receipt of a new motor generator the name plate should be carefully inspected. If it be a D. C. to D. C. machine it is only necessary to make sure that the voltage marked on the name plate corresponds with the voltage of the supply. If it be an A. C. to D. C. set it is then necessary to make sure the volts, the cycles and the phase of the motor agree with those of the circuit to which it will be connected.

The name plate on the generator should indicate its maximum capacity. If the machine is to be located in a basement, or at any other place a considerable distance from the projection room, the projectionist should make sure that the circuits leading from the generator to the projection room, and from the main house switchboard to the motor are both large enough to carry the maximum current they will be called upon to carry with, not to exceed a two-volt, or at most a three-volt drop. (See Page 74.)

If the generator is to be located in a basement it is an excellent plan to place it on a foundation raised at least 12, and preferably 24 inches from the floor. This is particularly important if there is danger of the basement flooding, or if the floor is wet, though in either of the latter events it would be sheer folly to locate a motor generator set in the basement.

DROP LIGHT.—No matter where the machine is located there should be a drop light hung over it, with sufficient slack cord to admit of the light being carried to any part of the machine. This latter is especially important if the machine be located in a dark place, such as a basement.

GROUNDING THE FRAME.—The frame of the machine should be thoroughly grounded by means of a copper wire, one end of which must make good electrical contact with the frame and the other end with a water pipe or the earth, as per instructions, Page 346.

REMOVING SUB-BASE.—If the machine is mounted on a sub-base, which for any reason it is desired to dispense with, it is highly important that the base which will receive the machine be perfectly level, and that the motor and the generator be carefully lined with each other. If this latter be not perfectly accomplished there will be an undue, and possibly a heavy strain on the coupling between the two shafts. Imperfect lining of the motor and generator is likely to result in noise and vibration; it certainly will cause rapid wear of the bearings of both the motor and generator. Machines in which the armature of the motor and generator are mounted on one shaft, with but three bearings and with no coupling between the two armatures, should under no circumstances be installed without their sub-base, if they be of the type which uses a sub-base.

Where a motor and generator are carried on a single sub-base or base, it is not necessary that they be bolted to the floor, nor is it necessary to build any special foundation for them.

CORK, FELT OR RUBBER.—Motor generator sets in which both elements are carried on a single base or sub-base require no base, but between them and the floor should be one of three things, viz.: a thick pad of cork, a thick pad of felt or a thick pad of fairly resilient rubber. These pads serve two purposes. They absorb any possible vibration, which would otherwise be communicated to the floor, and they serve to deaden the noise of the machine.

Cork is best, but the pad should be two or three inches thick. It need not extend all the way under the machine if the machine be of the horizontal type. If it be of the vertical type it will be just as well to use a pad or mat the full size of the machine, and two or three inches more. If the pad be of felt it should be of the kind ½ to one inch thick, and four or five thicknesses should be used. We can give no advice with regard to the rubber pad, because it will depend upon the kind of rubber you are able to get, but in any event a sufficient thickness should be used to absorb all the vibration.

It is imperatively necessary that the armature of horizontal type motor generator sets be perfectly level endwise, else it will not "float" (have end play), and failure to float will probably produce grooved bearings and commutator. For this reason it is necessary, after the machine has been set on its pad for a week, that it be tested, and if necessary levelled by slipping sheets of paper or metal under the low end. See Page 524, Figure 155.

CAUTION.—In the case of motor generators the armatures of which are joined by a coupling and which are not mounted on a single, rigid iron base, the pad method does not apply. Such machines must be bolted down to a solid, rigid foundation, the top of which is, of course, perfectly level.

ELECTRICAL CONNECTIONS.—Wiring diagrams and instructions should accompany each machine. It is hardly to be expected that the projectionist will be able to make the electrical connections for a motor generator, since there not only are several different makes, but more than one type of some makes; also there are single two and three-phase current complications. It is, therefore, to be expected that the electrical connections of the machine will be made by a competent electrician.

FINAL PREPARATIONS FOR STARTING.—After the machine is installed and the electrical connections complete, before starting, revolve the armature by hand and see that it moves freely. Examine the armature and commutator carefully to see that they are not bruised and that everything is in good condition. Examine the face of the brushes and test the brush tension. (See General Instruction No. 7.) Let the oil out of the oil wells and fill them up with fresh oil. (See General Instruction No. 3.) Having taken these precautions, the machine is ready to be tested with current.

CENTRAL INSTRUCTION NO. 3—OIL.—It may be stated as a general proposition that the various largely advertised patent oils are absolutely unfit for motor or generator lubrication. If they be used it is more than likely that there will be trouble with the bearings, or a comparatively frequent and unnecessary expense for bearing renewals, in addition to which there will be a still more serious item, viz.: worn journals.

The character of the oil to be used will depend to a considerable extent upon climatic conditions, but it is safe to say that **the oil used by the local power plant for lubricating its generators will fill the bill.** The superintendent of the plant will undoubtedly extend the courtesy of telling you what it

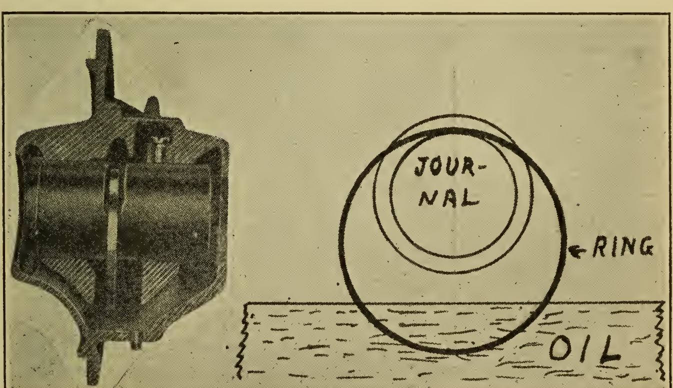


Figure 148.

is; also he probably will be willing to sell you a five gallon can at reasonable figures, and a five gallon can should last a long time. If you are able to procure the power plant oil you certainly cannot do better, because oil used to lubricate the heavy generators of a power plant must, in the very nature of things, be a good lubricant, and one suitable for use on motors and generators.

If you are unable to procure the oil used by the local power plant, then we would recommend for summer use a medium heavy dynamo oil, which may be used the year round if the motor generator be located in a room that is kept warm. If, however, the machine is in an unheated place, then in winter time a light dynamo oil will give the best general satisfaction.

BALL BEARING MACHINES.—Some machines are fitted with ball bearings, in which case provision is usually made for the use of either oil or grease. The amount of oil or grease required by a ball bearing is very little, its function being more to keep the races and balls free from rust than to actually lubricate them.

It is imperatively essential that only a lubricant containing no acid be used with ball bearings. An oil containing, for instance, animal fat, will finally roughen the polished surface of the balls or races and bring about the final destruction of the bearing. For this reason it is very much better that the suggestion of the manufacturer of the machine be implicitly followed in the matter of selecting a lubricant for its ball bearings.

CAUTION.—Most, if not all, motor generator sets of the horizontal type have the oil carried up to the journals by means of rings which rest on the journal and revolve merely by the friction of their own weight thereon. This type of bearing is illustrated in Fig. 148, in which we see an oil ring, the lower part of which runs through the oil well below the journal, the upper part resting on the top of the armature shaft, provision being made for this by a slot or groove cut in the babbit bearing. At the left it is shown photographically and at the right diagrammatically. You may understand the action of the ring by placing an ordinary iron ring on a short piece of iron pipe considerably smaller than the ring and revolving the pipe. You will see that the ring also revolves, though very much slower than does the pipe.

Once the action of this kind of an oil arrangement is understood, two things will be plain, viz.: first, since the lower half of the ring is immersed in oil, oil will be continually carried up to the journal by the ring. Second, if the weather be cold and the oil be stiff, then the friction of the journal may not be sufficient to revolve the ring, hence the journal will receive no lubrication until it has heated up sufficiently to melt the oil. For this reason a too-heavy oil must not be used in winter if the machine is located in a cold room.

CAUTION.—Be sure your oil is free from dust or sediment. Never leave an oil receptacle standing open. If you do it will collect dust and its lubricating quality will be greatly impaired. **Dirty oil very frequently is the cause of trouble in bearings, and in any event it wears bearings very fast.**

GENERAL INSTRUCTION NO. 4—CLEANLINESS.—It is important that all parts of motor generators be kept scrupulously clean. Oil should not, under any circumstances, be allowed to collect either on the machine or on the floor near it, and the machine should be kept free from dust. A medium size hand bellows will be found very convenient for removing dust from the armature, from around the pole pieces and in other inaccessible places. **A dirty machine is evidence of a lazy, indifferent or incompetent attendant.**

GENERAL INSTRUCTION NO. 5—LOOSE CONNECTIONS.—It is highly important that all electrical connections and all bolts and nuts be inspected periodically and tightened up, and all electrical connections be kept not only tight, but perfectly clean. **Loose connections are a continual source of unnecessary trouble.**

GENERAL INSTRUCTION NO. 6—AMMETER AND VOLTMETER.—Motor generators are, or should be, provided with both an ammeter and voltmeter, which instruments, in order to serve their best purpose, must be located within view of the projectionist when he is in working position beside the projector. **These instruments should be constantly under the eye of the projectionist.** It is a serious mistake to locate them where they cannot be read easily and continually observed, because there are certain points at which the arc furnishes maximum illumination with minimum current consumption, and if the ammeter and voltmeter be located within plain view of the projectionist, preferably on the front wall of the projection room, near the left hand projector observation port, the projectionist is very much more likely to handle his arc efficiently. This is especially true if the arc be hand fed.

GENERAL INSTRUCTION NO. 7—CARE OF THE COMMUTATOR.—The commutator of a D. C. motor or generator should require very little attention, but sometimes it does require a great deal.

The best evidence that the commutator is in first-class condition is a sort of glazed appearance, smooth as glass, a rather dark brownish shade in color, and a slight squeak from the carbon brushes when the armature is revolved slowly. To obtain and maintain this condition the following care is essential:

(a) Brushes, set as nearly as possible at the sparkless point, which point may, with the old style generator lacking the inter or "commutator" pole, vary with the load. On the newer type generator the inter or commutating pole is used, and the manufacturer marks the point at which the brush yoke should be set by making either a chisel or a center-punch mark on the yoke and on the frame. Some manufacturers fill these marks with white paint so that they are very easily seen; some do not. **If these marks are present the brush yoke should always be set so that the marks on the frame casting and on the yoke coincide or, in other words, are opposite each other.**

(b) The brushes must have sufficient tension to make good electrical contact with the commutator, **remembering that every particle of unnecessary pressure will tend to unduly wear both commutator and brushes.**

(c) The commutator should be kept clean and free from dust. This may best be accomplished by cleaning the whole machine every day, blowing the dust out from around the field poles, etc., with a bellows, and last of all, wiping off the commutator with a canvas pad made as follows:

Cut a piece of ordinary canvas 6 inches square. Fold same so it is 2 inches wide by 6 inches long, which will form a pad with a face of one thickness, backed by two thicknesses. Next open up the pad and smear a little vaseline on the center section, which is the back side of the face of the pad, after which refold and let lie a few hours in a warm place, whereupon it is ready for use.

Sufficient vaseline will gradually soak through the canvas to give the commutator all the lubrication it needs, which is very little. The foregoing holds good in summer, and in winter, too, if the generator is located in a warm room. If, however, the machine is cold, then it will be well to moisten the face of the pad by using a few drops of a very thin oil on a piece of glass, spreading it around evenly and then wiping it off on the face of the pad, the idea being to get the oil evenly distributed on the pad.

Remember this, however, **too little lubrication is better than too much, and heavy lubricants (thick oils) must never, never, never be used on a commutator.** If one application, as above, during every six-hour run does not suffice, then it is likely that (1) brushes have too much tension, (2) machine is overloaded, (3) brushes not properly set, or (4) someone has put in the wrong kind of brush, which of course is not likely to happen if the machine be a new one just from the factory, but is quite possible if it be a second-hand machine, or one which has been in a repair shop.

Never use gasoline or benzine around a commutator; it is likely to attack and soften the shellac and insulation, and thus set up serious trouble.

CAUTION.—Where the mica insulation of the commutator is undercut, great care should be taken with regard to lubricating of the commutator. **If a soft brush is used no lubrication at all should be applied.** This last caution is necessary with undercut insulation, because the lubricating medium will have a tendency to combine with carbon dust and fill up the space between the commutator bars, thus in time possibly short circuiting the bars; also where soft brushes are used the brushes themselves, as a rule, contain sufficient paraffine to provide all necessary lubrication.

(d) See to it that sufficient oil, or combined oil and carbon dust, does not collect at any point or spot, either on the commutator or the face of any brush, to form a semi-insulation.

(e) That there are no high or low bars, and that the commutator is perfectly round.

(f) That a fragment of copper does not drag across the insulation between two adjacent bars, or that oil and carbon dust do not form such a bridge. This fault will be evidenced by a thin, sparkling ring of light around the commutator.

(g) That the brush springs do not carry sufficient current to heat them.

(h) **That the brushes fit properly in their holders, and are kept free from accumulation of dirt, dust, etc.** They should be taken out, their faces examined, and if necessary cleaned at the end of every 60 hours' run.

(i) That the brushes are neither too hard nor too soft.

(j) That the armature of horizontal type machines "floats" slightly, i. e., has from one-sixteenth to one-eighth inch end play, according to size of machine. This tends to prevent the brushes from cutting grooves in the commutator, hence is very important. Unless the machine sets perfectly level the armature will not "float," hence a **level setting is important.** (See "Installation" Page 498.) In vertical machines in which the armature is carried on thrust ball bearings, the brushes of opposite polarity overlap, so that the space between the brushes on the one side is covered by a brush on the other. This arrangement causes a very even, uniform wear.

(k) That the copper and mica insulation wear down evenly.

(l) That the generator is not overloaded, and that there are no other faults present which would tend to cause unnecessary sparking, or otherwise injure the commutator.

SPARKING.—Should the brushes of the motor or generator show excessive sparking, it may be attributed to one of the following causes:

(a) If it be a belt driven machine, the belt may be slipping; if the sparking is spasmodic or intermittent the trouble will probably be found in the belt, since belt slip causes sudden variations in speed, and this will, in itself, cause sparking, because it has the effect of producing heavy fluctuations in voltage. The remedy is to tighten the belt or use a belt dressing, and in this connection ordinary black printer's ink is as good an article as we know of to stop belt slipping. Ten cents' worth obtained at any printer's will last a month or more.

(b) In considering the following remember that if the machine is a new one and the rocker arm is set at the position marked by the manufacturer, as before explained, the rocker should under no condition be shifted, since the entire performance of the generator depends, in some cases, on the accurate positioning of the brushes.

Brushes not set correctly, that is to say, the rocker arm too far one way or the other; also the brushes may be too close together, or too far apart. In the first case the remedv is to move the rocker arm until the neutral position is found, whereupon sparking will either cease or be reduced to a negligible quantity. If this fails to remove the trouble, we would see if the brushes themselves are the correct distance from each other. In a two-pole machine they should bear on the commutator at diametrically opposite points. That is to say, the distance from brush-point to brush-point should be exactly the same when measured both ways around the commutator; in other words, distance A should equal distance B, as per upper drawing, Fig. 149.

If it be a four-pole machine, with two positive and two negative brushes (four altogether), the correct distance is one-fourth of the circumference of the commutator between the points of adjacent brushes; that is to say, distances marked X should all be equal, as per lower drawing, Fig. 149. If it be a machine with more than two positive and two negative brushes (more than four brushes all told), divide the number of commutator segments by the number of poles or field coils of the machine. The result will equal

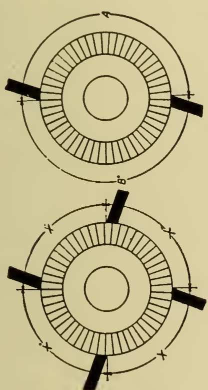


Figure 149

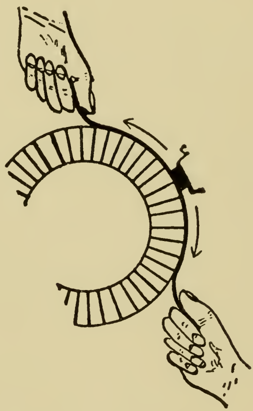


Figure 150.

the distance, in commutator bars, the brushes should be apart.

(c) Dirty brushes or dirty commutator may cause sparking, or may even prevent the generator from picking up its load at starting, and will sometimes cause a badly fluctuating arc. Some of the causes of dirty brushes and dirty commutators may be found in one of the following:

Carbon brushes contain a small amount of paraffine. When the carbon gets warm, if it be excessive in quantity, it is likely to ooze out and coat the commutator thus forming a partially insulating coating in spots, or the paraffine may mix with dust and coat the end of the brush with a semi-insulating compound. The obvious remedy is to clean the dirty parts.

To clean the commutator, use a brush stiff enough to remove any foreign matter which may cling to its surface, yet not stiff enough to injure the surface. If the brush will not remove the deposit, then use 00 sand paper **(NEVER use emery paper or emery cloth on a commutator)** applying the same while the commutator is revolving, but with just barely enough pressure to clean the metal. After having cleaned the surface, put a few drops of light oil on a cloth, or use the pad already described, holding it lightly to the commutator as it revolves. Don't get much oil on the surface of the commutator—just a "suspicion," as it were.

If it is a carbon brush which is dirty, or which does not fit the curve of the commutator, raise it just enough to slip a piece of No. ½ sandpaper between the brush and commutator, with the sand side against the brush, and pull it back and forth around the curve of the commutator until enough of the brush has been ground away to clean the surface, or to make it fit the commutator. This is illustrated in Fig. 150.

Do this very carefully. If the brush fits loosely in the hole it is best to sand in the direction of rotation only, else the brush will wiggle back and forth with the sandpaper, thus injuring rather than improving the contact. Be sure and always clean the commutator thoroughly after doing this, since if carbon dust is left adhering to its surface it may work into the insulation and cause a local short circuit between two bars.

(d) The brush not making proper contact with the commutator, which may be due to (1) tension spring not strong enough; (2) tension spring having lost its temper; (3) brush stuck in its holder; (4) brush not fitting the curve of the surface of the commutator; (5) brush holder set at the wrong angle; (6) high bar or insulation.

The remedies are: (1) Stretch the spring, if it is a spiral spring and in compression, or cut down its length if the spring be in tension. If it is not a spiral spring, do whatever is needful to make the spring stronger, installing a new one, if necessary; (2) put in a new spring and, since the fact that the old spring has lost its temper is evidence that the spring itself is carrying too much current, reinforce it with a current-carrying jumper; (3) the remedy is obvious: do whatever is needed to loosen the brush; (4) use sandpaper, as before described, until the brush fits the commutator surface; (5) straighten the holder; (6) see section f, further on.

There should, however, be only sufficient tension on the brush to insure its making good contact with the commutator. Be careful, therefore, and don't get your springs too strong. If you do there will be unnecessary wear both on the brush and the commutator, which will to some extent add the element of mechanical heat generated by undue friction.

Reasons for the brush sticking in the holder are: (1) Dirt in the holder or on the brush; (2) brush not true; (3) hammer that rests on the brush (where that type of tension is used) not working true on the slot-end of the brush. The brush should slip freely in its holder, though not freely enough to allow of any considerable amount of play, and the hammer should be so adjusted that it lies true in the slot at the end of the brush. A brush which is not true may be evened up by tacking No. 1 sandpaper on a perfectly flat surface and rubbing the brush thereon.

(e) Commutator worn too thin. If the commutator wears down too much, although it may wear evenly and appear to be in good condition, the brushes will spark in spite of everything you may do, particularly when the machine is working at capacity. The reason may lie in the fact that since the segments are wedge shape, as they wear down they become narrower, thus allowing the brush to span more of the circumference of the commutator than was intended, or there may be a slight error in the setting of the brush holder, and this error becomes greater as the distance between the brush holder and the commutator increases. The only remedy is a new commutator, but the sparking may possibly be lessened somewhat by moving the brush holder closer to the commutator. This trouble appears at its worst in a series type machine.

(f) A high or low commutator segment. This fault may usually be detected by the clicking sound made by the brush in passing over the defective segment when the machine is run at moderate speed. When the segment is low the brush rides in toward the shaft each time the bad bar passes under it. If it is high the brush will jump. The remedy will depend somewhat upon the cause. It may be that the segment has become loose, in which case it may be driven back into place by tapping lightly with a wooden mallet, or by using a wooden block and hammering gently, but the armature will probably have to be taken out and sent to the repair shop unless you yourself can tighten the clamp ring—a rather delicate operation.

If the segment is high by reason of the fact that, being of harder material than its mates, it has worn down more slowly, then, using a fine file, it may by very careful work be dressed down. If, on the other hand, it is low, then the only remedy is to turn down the rest of the bars to match.

If the fault is slight, this may be done by removing the brushes and holding a piece of grindstone which has been turned out to fit the circumference of the commutator to it while it is revolved rapidly. This process is, however, slow. The best way is to put the armature in a lathe and turn it off. In the case of a motor the grinding may, however, be done with the brushes down and the machine running by its own power, but if this be attempted it must be done with great caution.

When you are through, the face of the brushes should be thoroughly cleaned by drawing No. ½ sandpaper drawn around the curve of the commutator with the sand side next to the brushes as per Fig. 150, in order to grind off their face and thus remove any particles of sand which may have become imbedded in the brush, since such particles would scratch the commutator and cause undue wear. It is better to do the grinding with the brushes raised and the machine run from some outside source of power, if it is practicable.

(g) A rough or eccentric commutator. This may be caused by improper care, or by the use of defective materials in its construction. A rough commutator may be detected merely by feeling. The mica insulation between the segments will either stand out in ridges or be worn down so that there is a small groove between the segments. An eccentric commutator may most readily be detected by holding some instrument firmly against the frame opposite the commutator so that its end just touches the bars.

If the commutator is true it will touch all the way round as the armature is slowly revolved, but if the commutator is eccentric it will, of course, only touch the high spots. If the eccentricity be bad it will cause the brushes to move in and out of their holders perceptibly when the armature is revolved slowly. The only remedy is to turn the commutator down, and this can only be successfully done in a machine shop where work of this character is understood.

In preparing to turn down a commutator the machinist should note whether the journal or bearing points run true when the armature is revolved on its centers in the lathe. Often the centers themselves are not true with the journals, due to a defective center or a sprung shaft. In either case if the shaft be swung on its centers in the lathe the commutator will show eccentric. A competent machinist will, of course, know what precautions to take in a case of this kind.

(h) Brushes having too high resistance, the evidence of which is that they get very hot and slowly crumble away at the end next the commutator. The remedy is to get good brushes.

(i) Low bearings. In some types of machines low bearings will throw armature out of center sufficiently to distort the magnetic field, which will cause sparking. The evidence of this fault is that the air gap between the armature and the pole piece is smaller at the bottom than at the top. The only remedy is to replace the worn bearings with new ones.

(j) Short-circuited armature coil. This trouble may cause the voltmeter to fluctuate badly and the shorted coil to heat very quickly. The coil may be shorted within itself, or there may be a connection between two adjoining commutator segments. Remedy: Locate and remove the short.

(k) A reversed armature coil. This may be located by holding a compass over each coil of the armature in turn, and sending a few amperes of direct current through the coil, with the brushes raised and resistance in series to limit current flow, or current from a battery may be used. The coil which causes the compass to turn in the opposite direction from its mates is the guilty party. The remedy is, reverse the connection or direction of the windings of the defective coil.

(l) A bent armature shaft. This of, course, will cause the whole armature to wobble. The only practical remedy is a new shaft.

(m) Overload. The most prominent symptom of overload is the armature heating all over. Sparking may be lessened but not entirely stopped by moving the brushes ahead or back. By "ahead" we mean in the direction in which the armature is revolving. The remedy is obvious. Get a machine of larger capacity, or reduce the load on the one you have.

(n) High speed sparking is caused by the brushes not being able to make proper connection with the commutator by reason of excessive armature speed.

(o) A weak field. This may be detected in a generator by the inability to pick up readily, and by failure to maintain normal voltage. In a motor the starting power is decreased, but the speed and current are increased. A weak field may be caused by (1) a loose joint in the magnetic circuit; (2) heat may lower the insulation of the field winding sufficiently to allow the current to short circuit through it; (3) there may be a metallic short in the field coil. Remedies: With a voltmeter test across each field coil; the one showing the least drop is the defective one. If all read the same, then there is a loose joint in the magnetic circuit.

(p) A shaky foundation, or anything else that causes vibration in the machine, may and probably will set up the commutator sparking. The only remedy is to eliminate the vibration.

Should a ring of fire develop, or something that looks like a ring of fire around the commutator, it may be caused by (a) a piece of copper pulled across the insulation between two bars; (b) an open circuit in the armature.

In the first instance the ring will not be strong, but just a thin sparkling streak of light around the commutator. The remedy is to remove whatever is causing the short between the bars, which can usually be done by holding a piece of fine sandpaper lightly to the commutator, though the right way is to stop the machine and hunt up the trouble, using a magnifying glass, if necessary.

An open circuit in the armature might be caused by a break in one of the armature wires itself, or in one of its connections with the commutator, and these in turn may be caused by excessive current burning off one of the wires; or a nick in one of the wires may be the seat of the trouble, or the commutator may become loosened and break off one or more of the leads. The defect may be readily located, as the mica will be eaten away from between the commutator segments to which the faulty coil is connected, and the segments themselves will become full of holes and burned at the edges.

If this trouble is caught in time, the "open" may be closed and the commutator turned up true. Sometimes, by reason of carelessness, abuse or overload, the armature becomes hot, which causes the solder on the connections between the coils and commutator bars to soften, whereupon centrifugal force will throw it out, and there will, of course, be trouble, though there may be no complete opening of circuits. The action, however, so far as the ring of fire be concerned, is the same as if there were, and the commutator bars will become blackened and pitted and their edges burned. But if any of the foregoing faults be caught in time they can be remedied; if not, it will be necessary to install a new commutator, and perhaps a new armature coil or coils as well.

GENERAL INSTRUCTION NO. 8. — Before starting the machine see that it is perfectly clean and that the brushes move freely in their holders and make good contact with the commutator. Also make sure that all connections are tight.

GENERAL INSTRUCTION NO. 9.—Bearings run hot. The first rule when a bearing runs hot is to see that the oil well is filled with good clean oil and that the oil-rings run freely, carrying the oil to the shaft. If a bearing runs hot on a new machine, shut down and wash it out with kerosene. The trouble is probably due to dirt that has accumulated in shipment. If the bearing has been running along satisfactorily and suddenly gets hot, flood the well with clean oil, leaving the drain cock open and pouring in the clean oil while the machine is running, to free the bearing from dirt. A change to a different grade of oil, either heavier or lighter, will often correct a bearing trouble of this kind. Never use water to cool a bearing. It may get into the insulation of the windings and cause worse trouble A machine with clean oil of the proper grade never gives trouble from hot bearings.

GENERAL INSTRUCTION NO. 10.—Heating. Many projectionists, who handle motor generator sets and are not posted as to the permissible operating temperatures of same, become alarmed when some part or parts of the apparatus feel very hot to the touch.

The fact that a motor or generator, or parts thereof, feel quite hot to the touch does not necessarily indicate an unsafe condition.

To determine the actual state of affairs, proceed as follows: The projection room should be equipped with a good thermometer with a centigrade scale, though a Fahrenheit scale can be made to serve, provided it will register not less than 200 degrees.

The American Institute of Electrical Engineers advises, in its standardized rules, a permissible maximum actual temperature of 90 degrees C, which is equal to 194 degrees Fahr., as the limit of safe operating temperature for motor or generator parts, or for transformer coils, et cetera. This means that inasmuch as the ordinary temperature of the human body is about 98 degrees Fahr. (blood temperature) 194 degrees Fahr. would be very hot to the touch.

The right way to measure the temperature of a part is to bed the thermometer bulb in a ball of rather stiff putty, and then place the putty against the suspected part, leaving it a sufficient time for the putty to get as hot as the part is. This will cause the thermometer to accurately register the temperature of the part.

Roughly, as applies to projection rooms, we may say that any part that is not more than 50 degrees C (90 degrees Fahr.) higher than the actual temperature of the room, is not exceeding the above named limit, and unless this limit be exceeded, the equipment will not be damaged.

NOTE.—To reduce Centigrade to Fahrenheit (C. to Fahr.) multiply the degrees Centigrade by 1.8 and then add 32. For instance, assuming a temperature of 40 degrees C., how much is it Fahr.? 40x1.8=72 and 72+32=104 degrees.

THE HERTNER TRANSVERTER.—The Transverter needs no introduction. It is giving service in projection rooms all over this and other lands. The earlier machines were all of the "upright" type in that the armature stood vertical with the D. C. element at the upper end. With the addition of the later units of larger capacity these were made horizontal and at the present time all machines of 100 ampere capacity and higher are made horizontal while the smaller ones can be specified either way.

The trade name "Transverter" was originally limited to the series machines built by this Company for the reason that they were all of the series type from 1915 when the first was put in service until 1919, when the multiple machine was also produced. It was the intention then to limit the use of the word Transverter to the series type, but it was afterwards found that its use was so firmly tied in with both types of the Company's product that it is today applied to both.

In the series type the generator is shunt wound, the double arc machine being designed to maintain practically constant amperage under a variation of from 50 to 130 in voltage. In practice this means that the generator voltage rises from its normal of between 50 and 60 volts when one arc is operating, to from 100 to 130 volts when two arcs are burning, without causing any change in amperage. This is accomplished without the use of any resistance in series with the arc, the maintenance of constant amperage under variation in voltage being entirely automatic.

The motor is mounted in the same frame with and immediately beneath the generator. In all but the 20 and 30 ampere sizes, the motor and generator armatures are mounted on separate shafts which same are coupled together in the following way: one-half a flange coupling is fitted to the upper end of the rotor shaft and the other is fitted to the lower end of the generator armature shaft. The hub of the fan which supplies ventilation is placed between the two halves, the driving torque being transmitted by a larger square driving pin in one of the flanges which sets in a square slot in the other. In the horizontal type the two halves of the coupling are further secured to one another with bolts. In the case of the vertical sets the armature with its shaft and coupling half

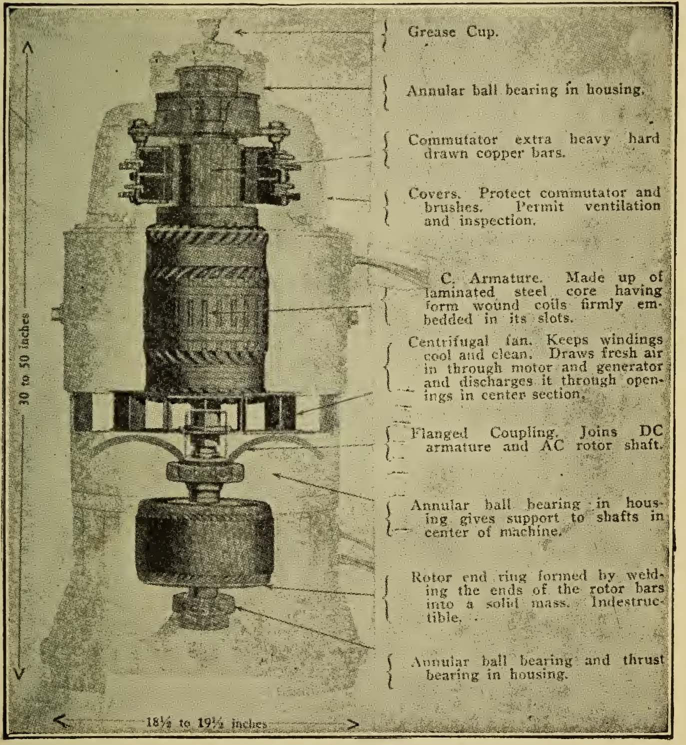


Figure 151.

can be lifted off the motor shaft without any removing of bolts or unfastening of any other parts.

In the 20 and 30 ampere sizes the armature and rotor are both mounted on the same shaft and are removed from the machine as a unit.

BEARINGS.—In the base of the machine is both a radial and a thrust ball bearing, Fig. 151, the latter carrying the weight of the combined armatures and fan. The center frame section carries a radial bearing, Fig. 151, and there is a radial bearing at the upper end of the generator armature shaft, Fig. 151, so that the armature is very well supported. The bearings are all ball bearings, and they are all arranged for grease lubrication.

CAUTION.—Grease for lubrication should be very carefully selected. It must be not only entirely free from graphite and acid, but also free from any elements which would in time form acid, because acid destroys the surface of the steel balls and the runways, causes pitting and works havoc. For these reasons we emphatically recommend that grease for use with the Transverter be purchased from its manufacturer, the Hertner Electric Company, Cleveland, Ohio.

The tendency is always to use too much grease on ball bearings rather than too little. Too much grease is not only a waste of good material but the excess is forced out of the bearing housings in such quantities that it is spread over the windings and other parts of the machine where it gathers dust and grit and may lead to serious damage.

The parts are shown in the phantom view, Fig. 151, which also gives the over-all dimensions. It will be observed that over the range of sizes covered by the three bearing vertical machine the changes come in the height rather than in the diameter.

The Transverter is supplied with either one of two types of panel, termed "Panel A" and "Panel B." These consist of an inclosed steel cabinet on which is mounted a field rheostat for the generator, by means of which the projectionist may vary the current from somewhat above to somewhat below normal. The panel also carries a voltmeter and ammeter for the arc circuit. The only difference in the two panels is that panel B carries two quick-break switches to be used in making change-over. It is for the two-arc machine.

The manufacturer's claim is that the Transverter should require no attention beyond keeping it reasonably clean, putting grease into the bearings as required, and renewing the brushes when necessary. This may be quite true, in a general way, but we would nevertheless advise the projectionist to examine the machine carefully, at set intervals, because that machine never was and probably never will be made which will not require more or less expert attention.

DON'T ROCK BRUSHES.—The rocker arm should never be moved, because the performance of the Transverter depends very greatly upon the correct setting of its brushes. This adjustment is very carefully and accurately made at the factory, and the correct position of the rocker arm is marked. **If after putting in new brushes the characteristics of the machine seem to be altered, it indicates merely that the brushes are not making proper contact with the commutator.** The fault will correct itself in time, or it may be immediately corrected by inserting a piece of No. 1 sandpaper between the brushes and commutator, one brush at a time, **sand side next the brush,** and with the full tension on the brush, drawing the sandpaper back and forth around the commutator until the brush face is ground to fit the curve of the commutator surface. See Fig. 150, page 505. If brushes are loose in their holder, draw sandpaper in direction of rotation only, since if you draw it both ways the brush will wiggle back and forth and will not fit the commutator.

Series transverters are made for all commercial frequencies of current, for all commercial voltages, for single and two or three phase, and with a capacity of from 20 to 150 amperes.

DOUBLE ARC INSTALLATION INSTRUCTIONS.—Transverters should be set on a floor which is entirely free from vibration. It is not necessary to bolt them down. Set the machine on the four cork pads which come with it. Its weight will hold it in place.

WIRING.—Make connection from the A. C. line service to the starting switch, and from the starting switch to the motor terminals, as shown in Fig. 152. Having done this, close starting switch and **make sure the armature rotates in the direction indicated by arrow on top cap of machine.** If, in the case of two or three-phase supply, the armature rotates in the wrong direction, it must be reversed by reversing one of the phases of the motor.

The variations in wiring a motor generator set to fit the conditions met in the various theatres are such that we cannot hope to cover them within the limits of this book and we recommend the projectionist or wiring contractor writing to the manufacturer for a diagram to suit his particular needs when he has a second hand set to install or if the diagram sent out with the new set has been lost.

We are however showing as typical examples first, a three-phase series set, Fig. 152, second a single phase multiple set, Fig. 152A, and last, two multiple three-phase sets installed to work in parallel, Fig. 152B.

CAUTION.—Do not attempt to change direction of rotation or polarity by changing connections inside the machine. The machines are all checked up complete, together with their equipment, when tested. The motor must be connected to proper side of the line, and connections to panels must be made correctly in order to bring polarity of instruments and lamp right.

FUSES.—Fuse the A. C., or motor side of these machines only. The D. C. side does not require fuses or switches, other than those shown in wiring diagram. The fuses at motor starting switch must be large enough to carry the maximum

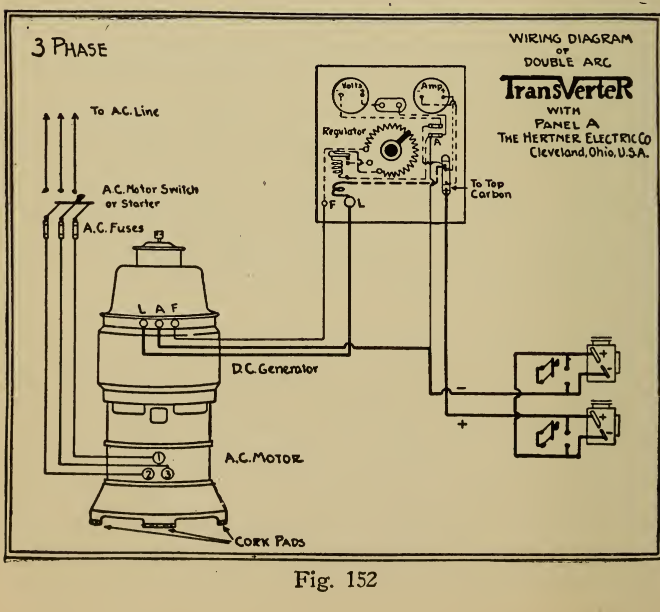


Fig. 152

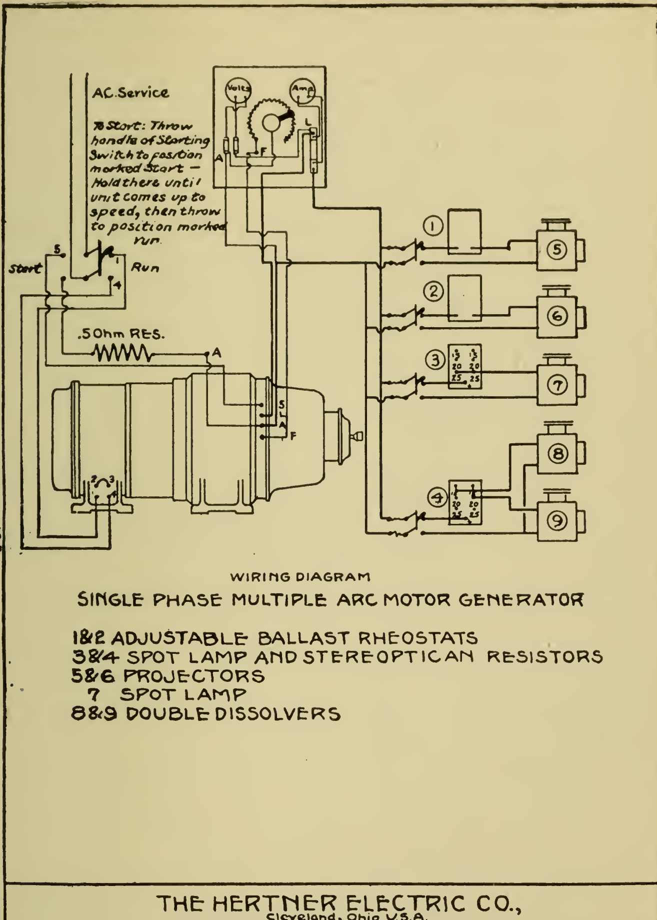


Fig. 152-A

load of the machine. Manufacturer's instructions, which accompany each Transverter, will give the proper size of fuses for each machine.

WIRING TO LAMPS.—Use wire of sufficient size to carry

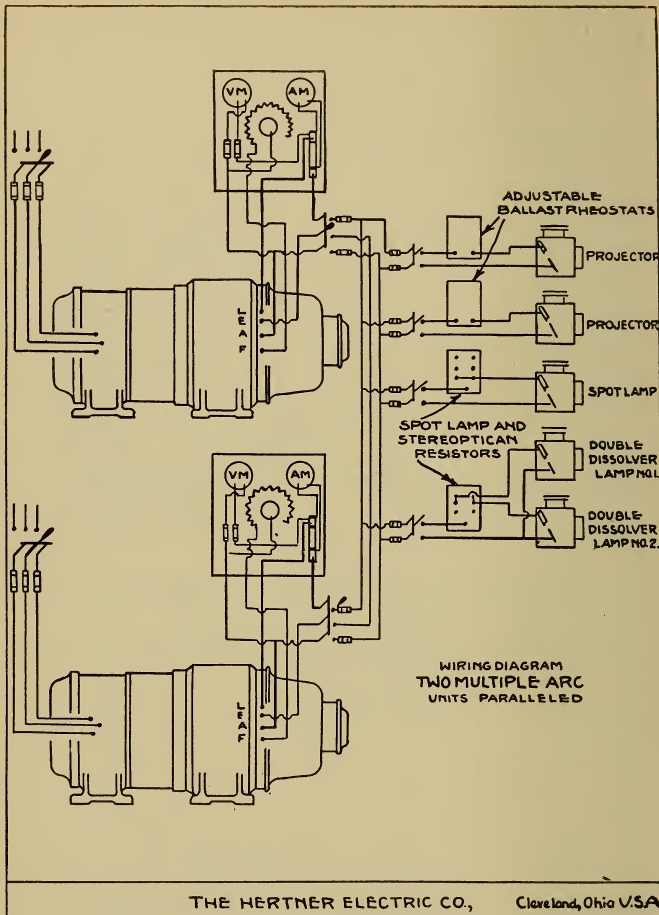


Fig. 152-B

the rated D. C. amperage from point L on Transverter to point L on panel board, Fig. 152. No. 12 or No. 14 wire may be used to connect point F on Transverter to point F on panel board, Fig. 152.

OPERATING INSTRUCTIONS.—Before starting motor, have lamp carbons separated and projector table switches open. Close motor starting switch. Close short circuiting switch which controls lamp you do NOT wish to use. Allow sufficient time for generator voltage to build up before attempting to strike an arc, say 15 seconds from time of starting motor, then bring carbons together, **instantly,** slightly separating them again. As the carbons heat up, gradually separate them until the proper arc length is had, whereupon the voltmeter will show 55 volts, provided the carbons be of correct size and correctly set. Any desired change in amperage, within the range of the machine, may be made by changing the position of the field rheostat regulator, but it must be remembered that the regulator provides means for obtaining amperage in excess of the rated capacity of the machine, **which excess should not be used continuously.** It is intended only to provide excess current for use where a temporary excess of light is desired by reason of a very dense film, or by reason of heavy tinting. The regulator also provides means for obtaining a less amperage than the rated capacity of the machine. If the projectionist will take advantage of this provision he will not only improve his work, but will also effect a considerable saving in light bills.

TO STRIKE A SECOND ARC.—Assuming one projector to be already in operation, adjust its arc to a 55-volt length, then bring the carbons of the idle lamp into contact, and, still holding carbons of idle lamp in contact, open panel board short circuiting switch controlling that lamp. When switch is open, instantly but slowly separate carbons, in the manner already directed for a single arc. When both lamps are in use the voltmeter on panel board will indicate the combined voltage of both arcs, which should read between 105 and 120 volts, probably about 110.

To "kill" either arc it is only necessary to close the panel board switch controlling that lamp. This in no way affects the remaining arc.

The multiple type is best suited to houses where spotlights, double dissolvers and other apparatus of widely different current requirements are used intermittently with the projectors. This is particularly true today when many houses operate at from 15 to 25 amperes on the projector, using a reflecting arc and require 50 amperes for the spot. With this low projector current the superior efficiency of the series system becomes of less moment and the flexibility of the multiple unit makes its advantage felt.

Mechanically the multiple generator is the same as the series type, the difference being electrical. The generator field is compound wound, the curve being held as flat as possible and the points of single and double arc are kept as nearly as possible at the same voltage level.

On the smaller units this voltage is about 85 maximum and on the largest ones, it is from 90 to 95 volt maximum.

The diagrams shown illustrate very clearly the general method of wiring which follows the usual practice of wiring any constant potential system. A departure from this, however, is gaining favor in houses where two generators are installed. This is accomplished by running a set of buses from each generator into the panel. Between these buses are double throw double pole switches wired to the various pieces of current consuming apparatus. This arrangement results in the projectionist being able to throw any piece of apparatus on either generator and it is meeting with much favor.

To start the multiple generator the switches to the load should all be open. Start the motor and observe that the generator builds up. When excited, close the switch controlling the arc to be operated and strike it. If the voltage of the generator is not correct when the arc has been struck, it should be corrected. It can then be loaded to its capacity.

The multiple machines are made regularly in sizes from 20-40 to 200-400 amperes and larger to order.

GENERAL CARE.—Keep the machine clean. **Do not use sand or emery paper on commutator.** Should the commutator become dirty, hold a piece of coarse canvas or cheese cloth firmly against its surface while machine is running, and when free of dirt, wipe the surface with a clean cloth pad, moistened very **SLIGHTLY** with pure vaseline. See Section C, general instructions No. 7.

Do not permit the brushes to become too short. If you do, disastrous sparking will result. A new set of brushes should be put in before the old ones are entirely worn out. **Instead of putting in a new set all at one time, it is better to put in two first, one in each holder, and at opposite ends of commutator. Run that way until the new brushes have worn to a perfect fit, whereupon you may replace the other worn brushes with new ones.**

The grease cups on the machine should be given one-half turn once every two (2) weeks. If this is done these cups will not require refilling for a number of months.

WHEN ORDERING PARTS FROM MANUFACTURER ALWAYS GIVE NUMBER ON NAME PLATE OF THE MACHINE.

GENERAL ELECTRIC COMPENSARCS.—The General Electric Company applies the name compensarc to three different types of machines, viz.:

The A. C. to D. C. Motor Generator Compensarc.
The D. C. to D. C. Motor Generator Compensarc.
The A. C. to A. C. Projection Transformer Compensarc.

The General Electric Motor Generator Compensarc, both A. C. to D. C. and D. C. to D. C. are horizontal type machines, designed for the operation of two projection arcs without resistance in series therewith. The arcs may be operated either singly or in series, amperage remaining constant, no matter whether one or two arcs are burning. The voltage of the generator, however, doubles when the second arc is struck. No resistance is used in series with the arc, either when burning singly or when both are in use.

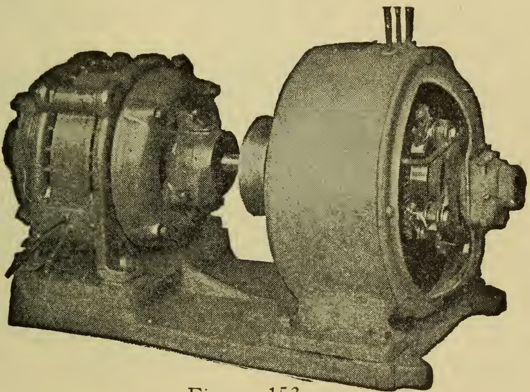


Figure 153.

The A. C. or D. C. type consists of an A. C. motor and a D. C. generator mounted upon a cast-iron sub-base, their armature shafts connected by means of a rigid coupling.

The general appearance of the A. C. to D. C. set is shows in Fig. 153, in which the smaller element is the A. C. motor. The motors are standard A. C. machines, but the generators are wound especially for projection work. These sets are built in five standard sizes, delivering 35, 50, 70, 100 and 125 amperes D. C. to the arc. The A. C. motor may be had for any standard voltage or current frequency, and for single two or three-phase current. The machines are well made and have been in use for quite a long while, giving excellent results and general satisfaction.

The appearance of the D.C. to D.C. is shown in Fig. 154. It consists of a D.C. motor and a D.C. generator, the armature shafts of which are rigidly coupled. They are intended primarily for use on high voltage D.C. current supply, the term high voltage being intended to indicate anything from 220 volts up. These sets and the A.C. to D.C. sets are made in the same standard sizes. If designed to operate from 110-volt supply the matter of electrical efficiency of the machine should have very careful consideration, but for 220 volts or higher there can be no question as to their being an excellent investment.

Each two-lamp series type motor generator compensarc consists of a completely assembled motor and generator and a steel cabinet panel for the generator, in which a field rheostat is mounted.

On its face is an ammeter, calibrated only for the operating range of the set. The black mark approximately in the center of the scale shows the normal point at which the set should be operated. Other marks indicate both the high and the low operating points. Beyond these two latter marks there is no calibration as they represent the extreme range of capacity of the machine.

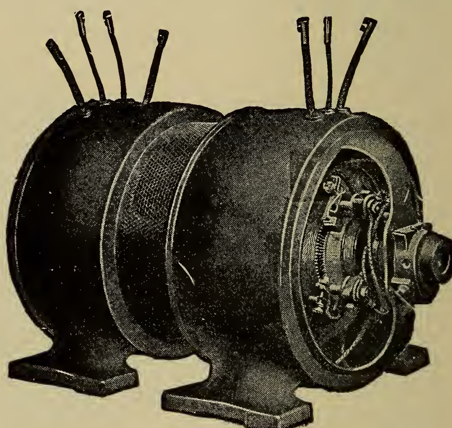


Figure 154.

The panel is so arranged that the front, carrying the rheostat and ammeter, may be removed, the cabinet be put in place, all conduit and wiring arranged and then the steel front carrying the ammeter and rheostat, put into place and connected. This is an excellent plan, in that it protects the instruments from any possible damage during installation. A door on the side of the cabinet gives access to connections for inspection and for test after installation.

The set includes two S.P.S.T. enclosed knife switches. These are the short circuiting switches. They are all ready for mounting on the projector, along with the main projector table switch and motor drive switch. Closing either of these switches has the effect of short circuiting the lamp it controls, so that no current will pass through the lamp. They should be connected ahead of the projector table switch. If this is done the idle lamp may be trimmed without opening the circuit.

The following are the dimensions data of the steel panel:

RATING OF COMPENSARC	AMMETER SCALE MARKING	DIMENSIONS IN INCHES		
		Height	Width	Depth
Two 35-amp. lamps	0- 30- 35- 40	11	8½	4¾
Two 50-amp. lamps	0- 40- 50- 60	11	8½	4¾
Two 70-amp. lamps	0- 60- 70- 80	11	8½	4¾
Two 100-amp. lamps	0- 90-100-110	17	12½	6¾
Two 125-amp. lamps	0-110-125-135	17	12½	6¾

When one arc is burning the process of starting the other is as follows: Close the projector table switch and freeze the carbons of the idle lamp. Next open the short circuiting switch of the idle lamp and separate the carbons in the usual way, except that it should be done very slowly. As the second arc is sprung, the machine automatically increases its voltage until it has double the voltage required to force the current against the resistance of one arc; in other words, until it is sufficient to force the current against the resistance of the the two arcs operating in series. Ordinarily this will be between 105 and 120 volts, varying with the amperage.

To strike either arc alone it is only necessary to open the short circuiting switch of the lamp you are going to use, close the other short circuiting switch and strike the other arc in the usual way. Under this condition the dynamo will automatically generate only that voltage necessary to force the current across the resistance of the single arc.

To extinguish either arc when both are burning, slowly feed the carbons of the lamp together until they are in contact, whereupon close the short circuiting switch of the lamp it is desired to extinguish. An arc may, of course, be extinguished merely by closing its short circuiting switch, but this would give the machine no chance to gradually decrease its voltage to meet the new condition. The bringing of the carbons of the lamp into contact with each other slowly, operates to lower the voltage of the generator gradually, so that there is no shock to it when the short circuiting switch is closed.

WESTINGHOUSE EQUIPMENT

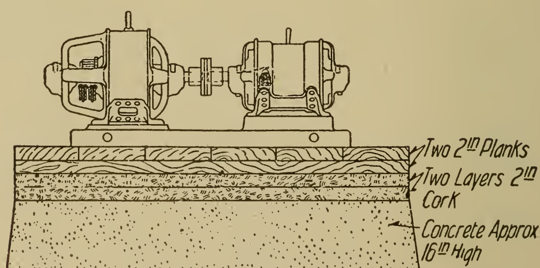
NOTE—In connection with this matter, examine General Instructions pages 495 to 512, inclusive. These instructions contain matter applicable to all motor generator sets.

UNPACKING AND INSTALLATION—See General Instruction No. 1, page 495. When removing new equipment from the crate, be sure the parts are not subjected to heavy shocks or blows. This is particularly important if the weather be very cold. UNDER NO CIRCUMSTANCES should a bar or other pry be so used that it will press against the windings—coils—of the machine. DO NOT REMOVE THE BLOCKING BETWEEN THE MOTOR AND GENERATOR UNTIL THE SET HAS BEEN INSTALLED ON ITS PERMANENT BASE.

NOTE—Should it ever become necessary to move the set off its base, do not do so until you have installed blocking between the motor and generator similar to that between them when they reach you. WARNING—Should you attempt to move the set without this precaution you will probably bend the bearings out of alignment, and experience trouble thereafter.

WARNING NO. 2—The equipment must NOT be installed in a damp place. On the contrary it should be well protected from dampness and moisture. BE CERTAIN THAT ALL WINDINGS OF MOTOR AND GENERATOR ARE DRY BEFORE TURNING ON THE CURRENT.

LOCATION—See General Instruction No. 1, page 495.



Sketch Showing Foundation for Motor-Generator.

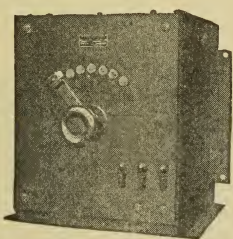
Figure 155

FOUNDATION—The manufacturer recommends a foundation such as is shown in figure 155. The floor line should be at the bottom of the concrete, so that the bottom of the base of the machine itself will be two feet above the top of the floor, which will bring the set at a height convenient for examination and handy to work on.

Such a foundation will assist in absorbing the vibration and hum incident to all motor generator sets, thus preventing it from reaching the structure of the building and being carried to the theatre auditorium. The manufacturer recommends that the concrete base be made hollow, with 2-inch-thick layers of cork on top of the concrete, and two 2-inch-thick layers of planking, layed in opposite directions on top of the cork, the two layers of boards to be securely nailed or bolted together or fastened together with ⅜ by 3 inch lag screws, their heads countersunk into the bottom of the planking.

The set is then mounted on the boards and may be bolted thereto, if thought necessary, by means of previously placed anchor bolts, or by heavy lag screws.

NOTE—An equal thickness of heavy felt may be substituted for cork, if desired, but cork is much the better of the two, because felt packs down after a time, and loses the greater part of its resiliency, whereas cork retains its resiliency almost indefinitely.



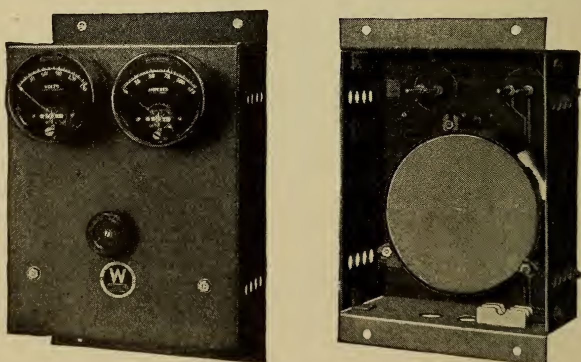
Ballast Rheostat
Figure 156

TOP PERFECTLY LEVEL—It is very important that the top of the base to receive a motor generator set be perfectly level. If it is not, then the oiling system may not function well; also, except in certain types of machines, it is best that the armature of horizontal sets be perfectly level, since when it is thus it will "float"—have slight end motion, which tends to prevent grooving the commutator and bearings.

A CHEAPER FOUNDATION—It is possible to build a rather heavy wooden platform to carry a motor generator set, and to mount this platform on helical springs—the sort you and I call "coil" springs. Such springs must be not less than three inches outside diameter and heavy enough to carry the set without "wobbling," but not sufficiently heavy so that they will not absorb the vibration of the set. Such a platform must be made to set perfectly level, and the springs must be bolted securely to the bed plate of the machine at their upper ends. We do NOT recommend this however. It is a make shift. Better do the job right.

SEALED SLEEVE BEARINGS—All late type Westinghouse motors and generators are equipped with what is termed "Sealed Sleeve" bearings. These are bearings so sealed that neither dust can get in or oil out. This is an important item where poor concrete projection floors exist, from which a dust arises constantly which is highly abrasive.

WIRING AND CONNECTING—The Westinghouse company issues an instruction book which contains full, detailed directions as to connecting their sets. Address the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania. Ask for their Motor Generator Equipment for Motion Picture Projection instruction book. We recommend that it be added to the library of all motion picture projectionists. Just tell the Westinghouse Company the Bluebook told you to procure it, and it will be sent free of cost.



Front View of Control Panel   Rear View of Control Panel

Figure 157

OPERATING INSTRUCTIONS—WARNING—The supply wires for motor generator equipment should have sufficient capacity to prevent the speed of the motor from being appreciably affected by voltage drop at anything up to a thirty per cent overload for a few moments, or up to 100 per cent overload for not to exceed say fifteen seconds.

BEFORE STARTING A NEW SET be sure that all oil wells are filled with high grade oil—oil suitable for dynamos. Oil well overflow plugs must be kept open. Draw off all oil at regular intervals, the length of which will depend upon the number of hours of use per day—just use common sense, remembering fresh oil is much cheaper than renewing bearings ruined by using oil too long. Refill with fresh oil. The oil removed may be filtered and re-used if desired, though we do not recommend it. DON'T try to "save" money by buying cheap oil, get the best there is.

STARTING—When installation is finished, including all electrical connections, close all switches, including lamp circuit. Move contact arm on generator field rheostat to point marked "IN" and then start the motor.

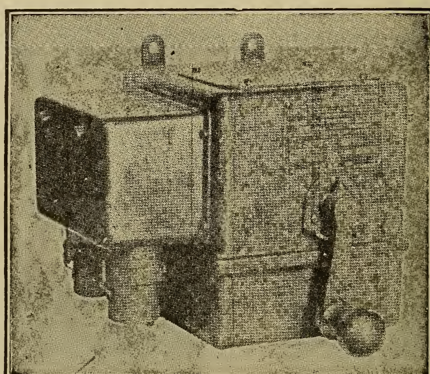
STARTING TYPE CS POLLY-PHASE MOTORS—Be sure the auto starter handle is in "OFF" position. Close the circuit breaker, if one be used, and then the main switch. Move auto starter handle to starting position. As soon as the motor armature has reached nearly full speed (very soon you will be able to judge this closely) move auto starter handle to running position. DO NOT LEAVE AUTO-STARTER HANDLE IN STARTING POSITION. If an auto-starter be not required—if it is not a part of the installation—, then the starting switch must be closed in starting position and left until the armature has attained nearly full speed, whereupon throw the switch to running position. See "REVERSING DIRECTION OF ROTATION."

STARTING TYPE AR SINGLE-PHASE MOTOR—Close line switch, whereupon the motor will start as a repulsion motor, with current flowing through the brushes and commutator. When full speed is reached, a centrifugal governor, located inside the armature, automatically short circuits the armature windings, which causes the motor to run as a squirrel-cage induction motor, the brushes being thrown off contact by the end thrust of the armature.

Note—If local power company requires it, a starting rheostat must be used for starting the motor, though the motor may usually be thrown on the line direct. If a starter is required, it is the same as for SK D. C. motor described further along.

Should the motor not reach full speed, which fact is evidenced by continued sparking at the brushes, the motor is over-loaded and will over-heat. Presumably there is an overload on the generator, which may be due to a heavy ground. Test your generator circuit. SEE "REVERSING DIRECTION OF ROTATION, page 530.

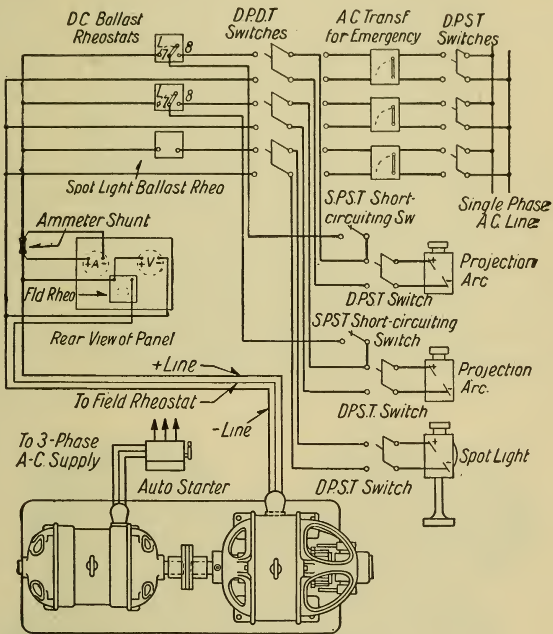
STARTING TYPE SK DIRECT CURRENT MOTORS—When installations are completed, and all electrical connections made, the oil wells filled with oil and all load switched off the generator, set handle of starter, or "controller" at "OFF" position. Close switch or circuit breaker, and move handle of starter or controller slowly, step by step, to run-



Type 815 10-Horsepower Maximum Motor Starting Switch
Figure 158

ning position. Fifteen seconds time should be sufficient to bring motors of ten horsepower or less to full speed; larger sets will probably require about double that time. WARNING: The time required, however, varies with the torque (pull) necessary to start the set. If the motor does not start when the starter or controller is on the third step, open the line switch or circuit breaker and move handle of starter or controller back to "off" position; then look for loose or faulty connection or for load on the generator. SEE "REVERSING DIRECTION OF ROTATION," page 530.

IMPORTANT—Immediately after starting a set of any type, raise oil well covers and be sure that oil is being carried up to the bearings by the oil rings, which must rotate with the journals. This is especially necessary in very cold weather.



Multiple of Parallel Arc Equipment
Diagram of Connections

Figure 159

TO STOP TYPE CS POLY-PHASE MOTOR it is only necessary to open the main switch or the circuit breaker, whereupon the automatic starter handle will automatically move to "OFF" position. In case neither switch or circuit breaker is used, you have merely to move the handle of the automatic starter to "OFF" position, which will stop the motor.

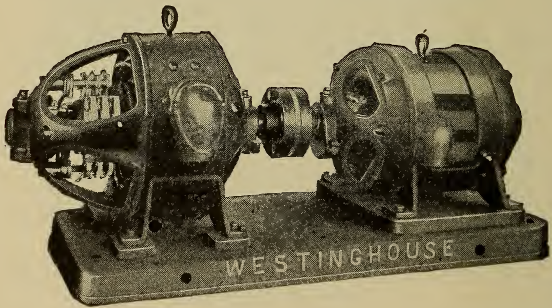
TO STOP TYPE AR SINGLE-PHASE MOTOR it is only necessary to open the main switch or circuit breaker.

TO STOP TYPE SK DIRECT CURRENT MOTOR, if a starting rheostat be used, merely open the main switch or circuit breaker.

WARNING—Do NOT force the starter handle to "OFF" position, but permit it to return there of its own accord.

REVERSING DIRECTION OF ROTATION—The armature of a motor generator should revolve clock-wise when viewed from the generator end of the set. If this be not the case, then the direction of rotation must be reversed by altering the wire connections.

REVERSING ROTATION DIRECTION of Type CS polyphase motors is done as follows. If it be a 2-phase 4-wire motor, the connection of two leads of one of the phases should be reversed. If it be a 2-phase 3-wire motor, then one phase must be reversed, as in the case of the 2-phase 4-wire motor. To do this, disconnect one phase winding from the "common" jumper and connect the other end of the same phase winding to the "common," connecting the end you disconnected to the line.

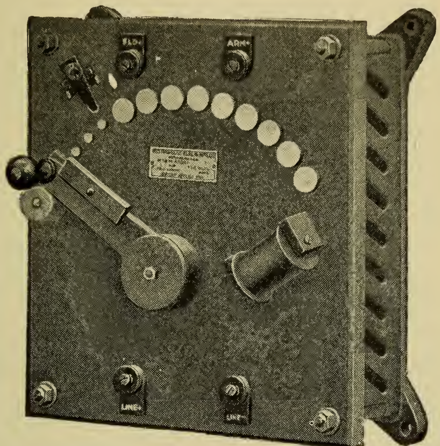


Motor-Generator, Single Phase
Alternating-Current Motor

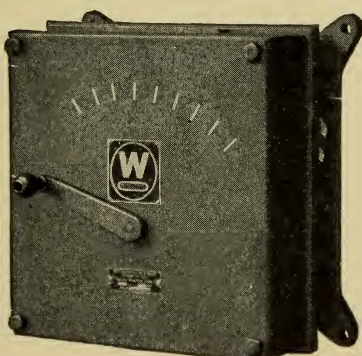
Figure 160

TO REVERSE A 3-PHASE MOTOR you have but to reverse the connections of any two of the wires.

TO REVERSE A TYPE AR SINGLE-PHASE MOTOR. In such motors the direction of rotation is controlled by the position of the brushes. It is indicated by a scale on the rocker ring, and a pointer on the front of the bearing bracket. The scale has three lines, marked, respectively, "RR," "N" and "RL."



3½ to 10 H. P.
Class 7010-A Starter—Cover Removed



Class 7010-A Starter—Safety Cover On

Figure 161

When the pointer is opposite RR the motor will run clockwise as viewed from commutator end. When pointer is at RL the direction of rotation will be counter clockwise. If pointer is at N the armature will not rotate at all, it being the neutral point. It therefore follows that in order to reverse rotation you have only to loosen the rocker-ring holding set-screw and move the ring to the position desired, as above indicated.

ADJUSTMENT—After you have the set running well, adjust the generator field rheostat (Manufacturer's recommendation) until the voltmeter reads approximately as follows:

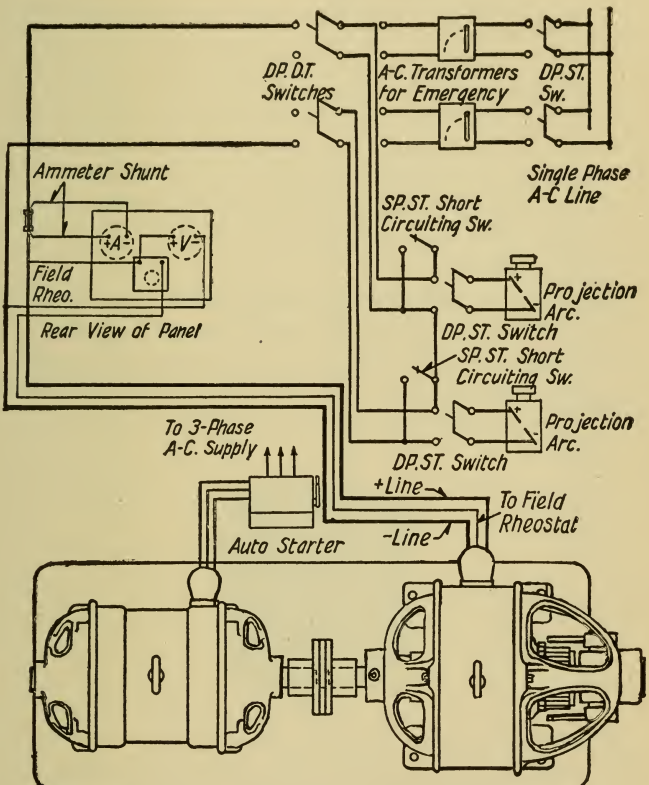
75 volts	for	2¼ Kw.	30	amp. generator
75 volts	for	2¾ Kw.	36.7	amp. generator
75 volts	for	3 Kw.	40	amp. generator
75 volts	for	4 2/5 Kw.	55	amp. generator
80 volts	for	5¼ Kw.	70	amp. generator
80 volts	for	5¾ Kw.	72	amp. generator
90 volts	for	8 1/10 Kw.	90	amp. generator
100 volts	for	11 Kw.	110	amp. generator

STRIKING ARC WITH SINGLE ARC EQUIPMENTS—For single-arc equipments the switch which short circuits the ballast resistance, (rheostat) (Figure 161), should always be opened before striking the arc. Strike the arc in the usual way by bringing carbons into contact and immediately separating them. Then close the short-circuiting switch and adjust arc length until voltmeter reads as follows:

Amps. at Arc	Voltmeter Reading
30	55
36	56
40	57
55	60
72	63
90	65
110	67
140	69
200	72
250	73

Note: Above is manufacturer's recommendation. Experienced projectionists may vary from it reasonably, if results are improved by such variation.

If when voltage is adjusted, the ammeter does not show desired reading, and generator is not producing up to its capacity, adjust ballast resistance to increase or decrease the amperage as desired, by moving the rheostat adjusting arm until desired current flows at arc voltage recommended or desired.



Clockwise rotation facing commutator of generator

Series Arc Equipment
Diagram of Connections

Figure 162

TO STRIKE ARC WITH 2-LIGHT EQUIPMENTS. The procedure is precisely the same as for 1-lamp equipments, treating whichever lamp you use as a separate unit, just as though the other lamp did not exist, projector table switch of idle lamp being, of course, open.

WESTINGHOUSE SERIES ARC EQUIPMENT—This equipment consists of a motor generator wound for constant amperage and variable voltage, a control panel, a field rheostat motor starter, and a short circuiting switch for each projector lamp. The generator is marked 65/130 volts, which means that when carrying only one arc it will operate at approximately the lower voltage when arc is correctly adjusted, and when two arcs are operating in series the voltage will be the higher figure.

THE SHORT CIRCUITING SWITCHES are single-pole single-throw knife switches. If mounted on the frame of the motion picture projector they must be enclosed in a suitable, approved protecting cover. If mounted on the switchboard panel, then no protecting cover is required.

Type A Auto-Starter

Figure 163

INSTALLATION—See General Instruction Nos. 1 and 2; also instructions for foundation, page 525. Control panel must be installed in the projection room, and in a place as convenient to the projectionists' working position as possible. The generator field rheostat is to be mounted on the control panel. The motor starting equipment should be either in the projection room, or in a room adjacent thereto.

WIRING AND CONNECTING—The following is the recommendation of the manufacturer as to wire sizes for different length of circuit.

Distance generator to Projectors	Size Wire, B & S Gauge 75 Amps	100 Amps.
1 to 100	3	1
110	2	1
120	2	1
130	1	0
140	1	0
150	1	0
160	1	00
170	0	00
180	0	00
190	0	000
200	0	000
210	00	000
220	00	000
230	00	000
240	00	0000
250	00	0000
260	000	0000
270	000	0000
280	000	0000
290	000	0000
300	000	0000

Full directions for wiring will come with each new set. If you purchase a used set, wiring directions may be had from the Westinghouse Electric & Mfg. Co., East Pittsburgh, for the asking. Just send them an exact copy of everything found on the name plate of the machine, being very sure to write your name and address very clearly.

To operate series arcs first close all switches in operating circuits, start the motor generator and let it come up to full speed. As soon as it is running normally, with all switches, etc., in normal position for running, OPEN THE SHORT CIRCUITING SWITCH OF THE LAMP YOU WILL BE USING, and as soon as the voltmeter shows about 100 volts, strike the arc you propose to use in the usual way by bringing the carbons together and separating them immediately, adjusting the arc to normal length. When starting the equipment it is best to have all the switches closed so as to operate the generator on a closed circuit, because the generator voltage will be very low. This prevents the field from becoming so hot and also prevents overtravel of the voltmeter hand.

THE CHANGE-OVER—When the time approaches for change-over, close the table switch on the idle projector and bring the carbons of its lamp into firm contact. With the arc in the projector you are using adjusted to normal operating voltage, open the short circuiting switch of the idle projector VERY SLOWLY. If, as the blade leaves the contact, there is an arc, CLOSE THE SWITCH AGAIN INSTANTLY. The arc is evidence that the carbons of the lamp are not making good contact, and if you open the switch under such a condition, you will probably break the circuit entirely, thus putting out the arc which is burning, leaving a blank screen until it can be again struck. If the carbons are in good electrical contact, no arc will appear as you open the short circuiting switch.

Immediately after opening the short circuiting switch, separate the carbons, RATHER SLOWLY, and adjust the arc to normal working length, whereupon you will have both arcs burning in series, and your voltmeter will show approximately double what it was before.

IMPORTANT—In closing down the projector which has finished its reel, do NOT merely shove the short circuiting switch shut. That will put out the arc, yes, but not in the best way. It is an unnecessary and rather heavy electrical shock to the generator to have half its load thus yanked off instantly. Instead, bring the carbons of the lamp into contact with each other, not too rapidly, then close the short circuiting switch and open the projector table switch. That is the RIGHT WAY TO DO IT. Merely closing the short circuiting switch, without first bringing the carbons into contact, is VERY BAD PRACTICE.

IMPORTANT—When the motor-generator is running idle you should keep BOTH short-circuiting switches closed, since this prevents the voltage building up to an abnormally high value, thus imposing over-travel of the voltmeter hand and probable heating of the generator field windings.

CARE OF MOTOR GENERATOR. Type SK. Commutator: See General Instruction No. 7, page 502. Brushes are set in the neutral position at the factory and the bracket which holds them is dowel pinned into permanent position, which should not be altered, since it is correct, no matter which direction the armature runs. NEW BRUSHES SHOULD BE OF THE SAME GRADE AS THOSE RECEIVED WITH THE SET. They should have no more clearance in the holder than will permit of their sliding freely in and out.

TYPE AR SINGLE-PHASE MOTOR—When brushes must be renewed, they may be removed as follows: Turn the rocker ring so that the brushes come between the arms of the bracket and remove the screws of the clips which hold the brushes in place. Pull out old brushes and insert new ones, replace the clip screws and turn the rocker ring until pointer is opposite line giving proper direction of rotation.

THE FRONT BRACKET OF MOTOR SHOULD NOT BE REMOVED UNLESS ABSOLUTELY NECESSARY. If it is removed, when replacing be certain that the steel pin in the brush-raising ring enters the corresponding hole in the brush holder casting. Failure to do this will probably result in poor operation of the machine.

REPAIR PARTS—Repair parts for Westinghouse Motor Generators should be obtained ONLY from the Westinghouse Company. When ordering parts be sure to give name of part wanted, AND SERIAL NUMBER OF THE SET UPON WHICH IT IS TO BE USED. Serial number is stamped both on end of armature shaft and on name plate of the machine. **Failure to send this number with your order will result in delay in receiving the part.**

New bearings may be obtained from the district office of the company which is nearest to you. Spare bearings should always be kept on hand.

If bearings over-heat the probable cause is (A) Poor lubrication, which may be due to (1) poor quality of oil, or (2) failure of oil rings to revolve. (B) Improper alignment of bearings. (C) Set not level, causing excessive armature end thrust or binding. (D) Rough bearing surface. (E) Bent armature shaft. (F) Grit or dust in the oil.

WHEN A BEARING HEATS excessively, flood it with heavy oil. If this does not cool it down, shut down the set, but keep the armature revolving slowly until the bearing is cooled down. This latter is IMPORTANT, since if it is not done the bearing and shaft may "freeze" together when cold, which would make a very bad condition indeed.

POINTERS ON OPERATION—It may sometimes happen that when a motor-generator set is started, its generator will not build up its voltage as it should. This may happen, even though the generator operated perfectly up to the time it was last shut down. This may be due to any one of the following causes, or to two or more of them combined:

(A) Slow speed, due to drop in line voltage or to motor trouble. (B) Open shunt field circuit, which may be either a (1) loose or high-resistance connection. (2) To a defective field coil, or (3) to a burned-out or damaged field rheostat coil. (C) An open armature or commutating-field circuit. (D) To incorrect setting of the brushes. See directions for setting them. (E) To reversed series or shut coil connections. (F) Poor contact of brushes with commutator. May be dirty commutator; dirty or burned brushes, or brushes sticking in holders. Examine this possible cause the first thing, should such a condition arise. (G) Loss of residual magnetism.

To remedy, first examine brushes and commutator, making sure that brush contact is good, commutator not dirty and brushes not sticking in holders. Try a temporarilly increased brush tension. Examine all connections and make sure they are in good condition, both mechanically and electrically. Look for a burned out or broken coil in field rheostat. A bell is not a reliable test for field windings, since sometimes the resistance of a field winding is so great that even a magneto bell will not ring through them when they are in perfect condition. An ordinary battery bell is useless for such a test. However, you may try a magneto bell, as it may work, and if it does ring through, then you know the field coil thus tested is alright. I only warn you that failure to ring is not conclusive proof that the coil is defective.

If the brushes and commutator are all right, the field rheostats alright and the field windings OK, then the trouble is probably either in the armature or due to loss of residual magnetism.

If nothing is found wrong with the armature, then it becomes necessary to excite the machine from another power source. Let A be the generator to be excited and B the generator power is to be taken from to do the exciting.

Remove all brushes from generator A and open all its switches. Connect the positive brush holders and the negative brushholders of machines A and B together. UNDERSTAND CLEARLY THAT BOTH THESE MACHINES MUST BE DIRECT CURRENT GENERATORS, hence you cannot use A C power lines for excitation of a D C generator. The connection above described should be made through a double pole knife switch, and through fuses of about five ampere capacity.

With generator B running normally, close the switch. If the shunt winding of generator A is in good order its field will show considerable magnetism. Generator A is running, of course, at time of test. With both machines running at full speed, reduce the voltage of machine B as much as possible and then open the connecting switch. If the voltage of B cannot be materially reduced, then set the field rheostat of machine A on the contact marked "IN," after which open the connecting switch slowly, gradually lengthening the arc which will be formed at the switch contacts, until it finally breaks.

SHOULD A NEW MACHINE REFUSE TO BUILD UP VOLTAGE, and the connections seem to be alright, reverse the field connections by interchanging the connections of the wires leading to the generator field coils. They are connected to the positive and negative terminals of the generator. If this has no effect, change the connections back as they were and seek a fault elsewhere, as before directed.

BRUSHES—Always fit brushes to the commutator perfectly, as per General Instruction No. 7, under division (c) of "Sparking." Briefly this is to lift the brush, place a strip of No. ½ sandpaper under it, under tension, sand side toward the brush, and draw it in the direction of armature rotation. Continue this until brush fits curve of commutator perfectly. After drawing the paper under the brush under its tension pressure, remove tension pressure and draw paper back. When you have finished grinding one brush, release the tension on it while you grind the rest of them. IF BRUSHES ARE COPPER PLATED, bevel their edges enough so that the copper does not come into contact with the commutator.

INSPECT THE BRUSHES frequently for (A) Brushes sticking in holders. (B) Tension readjustment as brush wears away. (C) Worn out brushes replaced before their contact with commutator is affected, or destroyed entirely. (D) That pig-tails are properly attached to brushes and holder. (E) That copper plating on brushes does NOT make contact with commutator bars. Keep brush edges beveled to prevent this. (F) EXAMINE CONTACT FACE OF ALL BRUSHES once a week and see that any copper adhereing to face of brush is removed, and that brush face is in good condition.

COMMUTATOR CODE—See General Instruction No. 7.

SPARKING—See General Instruction No. 7.

HEATING. That a motor or generator part feels hot to the sense of touch is no proof that anything is wrong. THE PERMISSIBLE TEMPERATURE OF PARTS IS 90 degrees Centegrade, or 194 Farhenheit. For correct way of testing temperature of parts see page 511. If it is not higher than that above quoted you need have no worry.

HEATING OF FIELD COILS may be due to a too-low speed of operation, to a too-high voltage, to brushes not correctly set, to the partial short-circuit of one coil, or to overload.

HEATING OF ARMATURE may be due to overload, to a partial short-circuit of two coils, which will, of course, heat only the coils affected, to short-circuits or grounds in armature windings or commutator, to poor commutation, or by high resistance connections.

HEATING OF COMMUTATOR may be due to either overload, sparking, to a too-heavy brush pressure or high resistance connections between commutator and armature winding.

BUCKING is the term used to describe arcing between adjacent brush arms. It is due to excessive voltage between commutator bars, or by abnormally low surface resistance on the commutator between brush-holders of opposite polarity. This condition may be due to (A) Rough or dirty commutator. (B) A drop of water reaching the commutator. (C) Short circuits on the line which produced excessive overloads.

MUSCLE IS CHEAP.
USE YOUR BRAINS.

THE SYNCROVERTER

The "Syncroverter" is a device concerning which we have little personal knowledge, but the fact that the Simplex Division of the International Projector Corporation has conducted exhaustive practical tests and has pronounced it O. K., has seemed to warrant a somewhat extended description of it in the Bluebook. This course is further justified by reason of the fact that the device presents several points of very decided advantage, in that it is free from appreciable vibration, light in weight, very compact and hghly efficent in operation.

CAUTION.—We would, however, caution you that in cases where line voltage is subjected to abnormal fluctuations, you should lay the facts before the manufacturer of the device, or his accredited agent, and secure from him an absolute guarantee that the Syncroverter will work satisfactorily under that condition. This does not, however, include the ordinary range of voltage fluctuation, which the machine is expected to take care of perfectly.

The Syncroverter is made by the Liberty Electric Corporation, Stamford, Connecticut, and is marketed by the National Theatre Supply Co., who have offices in all principal cities and from whom any additional data desired may be had.

In its present perfected type it consists of an 8-segment commutator, rotated by the horizontal shaft upon which it is mounted, by means of a motor having only the fraction of a horsepower. This latter is the only power expended in converting the current from A. C. to D. C.

The motor consists of a polarized rotor having no windings of any sort, which revolves within a distributed stator winding, the latter divided into two sections, one being the winding in use when the machine is in normal operation; the other a winding used only to start the motor.

The motor is brought up to speed just the same as is any induction motor. At the instant the rotor reaches a speed which synchronizes with the alternations of the power supply, its field is automatically excited by the rectifying commutator, whereupon the motor no longer operates as an induction motor, but as a single phase synchronous motor which is absolutely non-hunting, and has absolutely no phase displacement (These are manufacturer's claims) under any voltage or frequency within limits greatly in excess of the usual line frequency and voltage fluctuations.

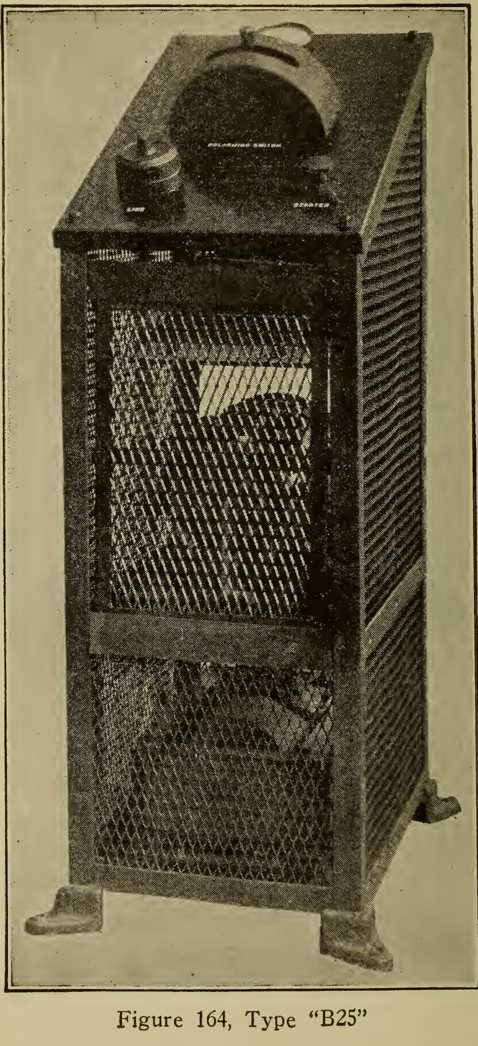


Figure 164, Type "B25"

The commutator is six inches in diameter, and of varying widths, the latter dependent upon amperage capacity of the individual machine. It is composed of alternate segments which are both mechanically and electrically connected. This means that each alternate commutator bar is thus connected clear around the commutator, thus forming two separate commutator units which are connected to the A. C. supply lines through sliding contacts made between stationary copper rings and rotating carbon discs, both the rings and discs having as their center the axis of rotation, or center of the shaft.

The rectifying action is obtained due to the fact that at the instant of reversal of the alternating current pulse, each succeeding contacting segment of the commutator has come into position which permits or causes current to flow only in one direction through the conductor attached to it.

Direct current is collected from the commutator by means of graphite brushes, which are electrically connected into two separate groups, one of which goes direct to the arc. The other group forms the return circuit from the arc.

The brush holder studs are mounted on a yoke, in the usual manner. This yoke may be rotated through a small angle (rocked back and forth) about the commutator, thus permitting shifting of the commutation point in order to secure the best results in rectification.

TRANSFORMER AN INTEGRAL PART.—The supply line voltage is reduced to arc voltage by means of a transformer, which is embodied in the machine itself and is an integral part thereof. It therefore follows that reduction of line to arc voltage is accomplished at only the usual loss inherent in a transformer, which should be well within 10 per cent. of the total. A well designed transformer is the most economical method used in practice for accomplishing this particular thing. The Syncroverter designed for motion picture projection work is, except for the wall panel used under certain conditions, an entirely self contained machine.

REFLECTOR ARC LAMP WORK.—For supplying current to reflector arc lamps the "Type 25" Syncroverter is especially designed. This unit is illustrated in Fig. 165. Its dimensions are, height 40 inches at back, width 14 inches, length 20 inches. Its weight is 250 pounds. All Syncroverters designed for motion picture work are completely protected by a pressed steel meshed fabric.

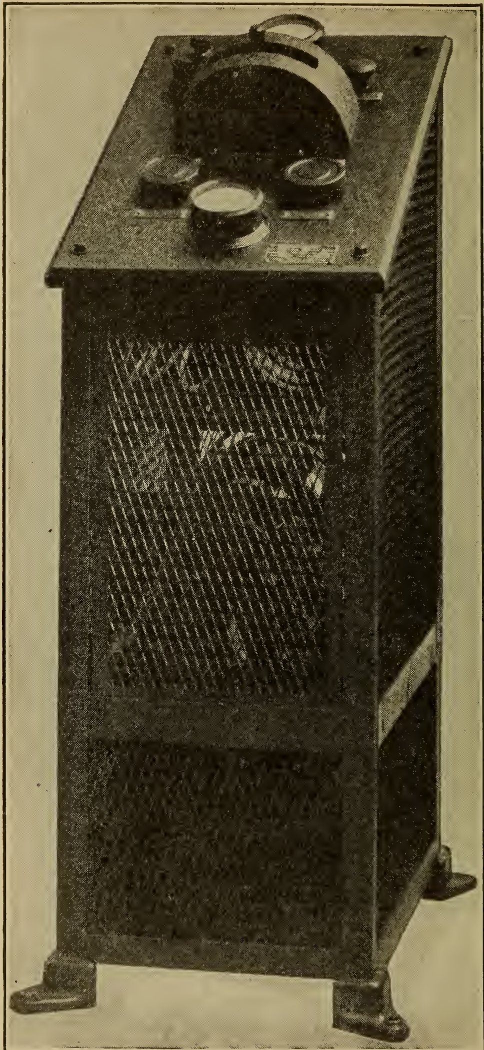


Figure 165, Type 25

If it is desired to install the machine within the projection room, then the panel board carrying the switches, etc., is mounted, at suitable angle, on the top of the machine itself. If it is desired to install the machine outside the projection room, then a suitable panel board is supplied, for installation at a convenient point on the projection room wall. This panel is illustrated in Figure 166.

The transformer is mounted within the machine itself, in a compartment immediately beneath the motor and commutator. It is supplied for any commercial voltage.

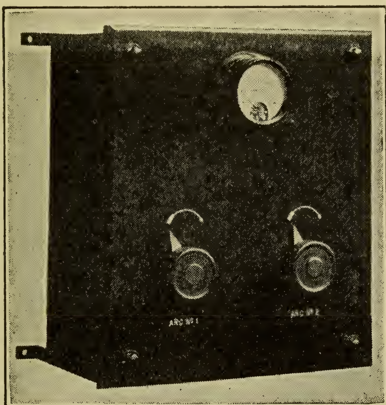


Figure 166 Wall Panel

The panel of the type 25 Syncroverter carries a double-scale O-center voltmeter; also a double-pole double-throw inclosed switch, the purpose of which is to insure correct polarity at the arc. Upon starting the machine the projectionist closes this switch, either to the right or left, according to the indication of the voltmeter needle. The main switch, also mounted on the panel, is of the snap-switch type; also a starting button is supplied. This latter is pressed down and held for about five seconds to start the motor. It then is released. An ammeter and amperage control also are mounted on the panel.

When it is desired to locate the Syncroverter outside the projection room, panel Fig. 166 is supplied, which carries the ammeter, switches and a separate amperage control for each arc. This panel is 13 by 18 inches in size and 6½ inches thick.

Since the line voltage is reduced to arc voltage by the transformer, and the current rectification is performed entirely by the commutator, the only operating power required is a small motor to rotate the armature against the friction of its brushes and the shaft bearings, hence the power consumption is negligible. The operation of the device is therefore highly efficient.

The machine is a single phase unit and, due to its small power consumption, may operate either from a power or a lighting circuit, provided the wires be of sufficient size to accommodate the arc amperage, plus the small power used in the machine itself. It has a unity power factor, which is an important item in computing power rate. It may be connected to a 3-phase supply by using only two legs of the circuit. The brush area is such that the machine will carry 100 per cent overload for a considerable period of time.

CHANGE-OVER.—The machine automatically supplies the required additional amperage when one arc is burning and the second one is put into operation, so that the first is not affected.

The Syncroverter is very simple in contsruction and operation. Its makers claim it to be very nearly entirely fool proof.

FOR EMERGENCY the transformer, which is a part of the machine itself, may be used to supply A. C. at the arc.

CAPACITIES.—The Syncroverter now (1927) is supplied in two models, and each model in two sizes. Type 25 has a normal rating of 25 amperes. It is capable of handling two 25 ampere arcs in multiple. When the second arc is struck the operation of the first will be in no wise affected. This type is entirely self contained.

Type 25-B is the same as the Type 25, but is supplied when the machine is to be installed outside the projection room, as it has a separate panel carrying ammeter and amperage controls, for installation within the projection room.

Type 26-S has a normal rating of 50 amperes. It will handle two 25 ampere projection arcs without overload, or one 50 ampere spot. It is recommended where two reflecting arc lamps and a 50 ampere spot are used. This type is made with projection room control panel, carrying ammeter, amperage control and spotlight switch.

FOUNDATIONS NOT REQUIRED.—Syncroverters run without vibration, hence no foundation is required. They are made for any line voltage from 100 to 550.

Please understand that all the above is manufacturers' statements, backed and sponsored by the Simplex Division of the International Projector Corporation.

THE ROTH ACTODECTORS

These machines are motor generator sets designed to receive A. C. from the supply lines, and to deliver D. C. to the light source. They will deliver any desired number of amperes D. C. up to the rated capacity. It is so designated that the arcs supplied by it must be connected in parallel (multiple) with each other if more than one be burned simultaneously. It will, of course, supply any number of arcs, of the same or of different amperage, up to the capacity of the machine. The striking or switching off of one arc does not appreciably affect any others which may be in operation at the time.

The Actodector consists of an A. C. motor—which may be had for any desired commercial voltage, cycle or phase—coupled to a 70-volt D. C. generator. The outfit includes an enclosed operating panel equipped with a voltmeter, an ammeter and a generator field rheostat with the usual control handle.

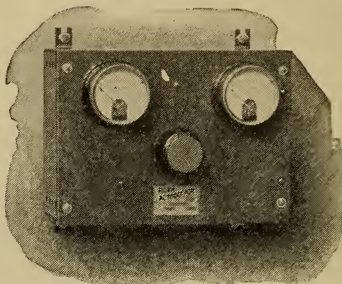
The machine is built in accordance with the established standards of the American Institute of Electrical Engineers, of the Electric Power Club and of the National Board of Fire Underwriters. It is approved by the Underwriter's Laboratory.

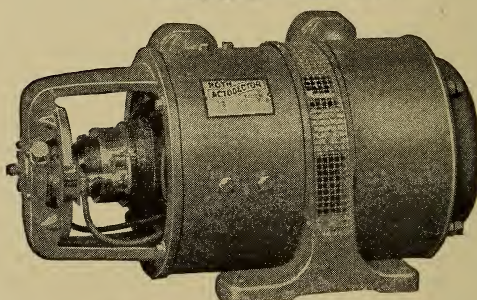
For motion picture projection, where not more than two arcs are used at a time, when one or more arcs are struck, the machine instantly, automatically, and without any manipulation of the generator field rheostat handle, supplies the right arc amperage and voltage. The series and shunt fields of the generator are so designed that a practically constant voltage is maintained at any amperage from no load to full load. All that is necessary is to set the generator voltage at 70, and strike one or more arcs.

The Actodector may be had in the following sizes; the double numbers meaning that each machine may be used for either one or two arcs of the capacity indicated:

25— 25 amperes	70 volts
35— 35 amperes	70 volts
50— 50 amperes	70 volts
75— 75 amperes	70 volts
100—100 amperes	70 volts

FOR REFLECTOR ARCS.—The 25—25 ampere Actodector, which is used for reflector type arcs, is a 2-bearing machine,





25-25 Ampere Polyphase Actodector and Instrument Panel

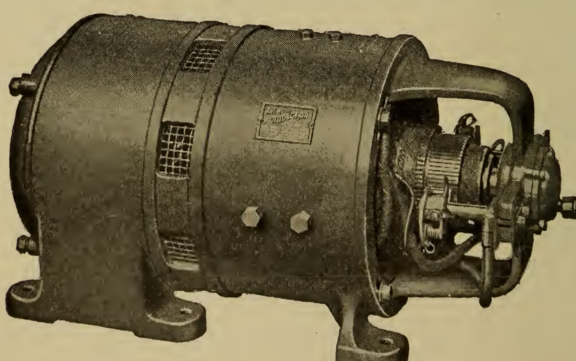


Figure 167
General Appearance of Roth 2-Bearing Actodector

except when it is supplied with a single phase motor, in which case it is a 3-bearing, 2-unit machine. Actodectors are all horizontal machines, and all except the multiphase 25—25 amperes machines are built with two separate units—separate motor and generator.

The motor rotor and the generator armature are both carried by one heavy shaft, supported at either end by heavy radial type ball bearings. The frames of the motor and generator are joined by means of a heavy, solid iron spacing ring, which gives a very rigid, compact type of construction.

The 2-unit actodector has a complete, separate motor and generator, the rotor and armature shafts of which are connected together by means of a flexible coupling. Both units are mounted rigidly on a heavy iron bed plate. Both units have large, sleeve type bearings.

RHEOSTATS.—For projection arcs, resistance in the form of rheostats is necessary to absorb the difference between the arc voltage and the 70 volt pressure supplied by the generator. Such rheostats may be purchased from any supply dealer. There must be one for each lamp to be operated. These rheostats are not supplied with the Actodector, unless specified when ordering.

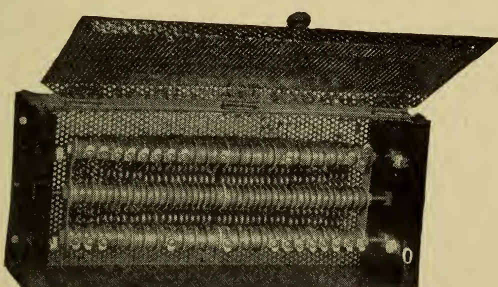


Figure 168
Ballast Resistors for Actodectors

THE PANEL.—The instrument panel is 10 x 14 x 8½ inches inches in dimensions. It is fitted with a voltmeter, an ammeter and generator field rheostat control. The face is hinged so that the interior of the metal box upon which it is mounted is accessible. It should, of course, be installed in the place where it will be most convenient to the projectionist.

MANUFACTURER'S CLAIM.—The manufacturer claims high efficiency for the Actodector; also that it is very simple and easy of control and operation.

INSTALLATION.—The Actodector must be installed perfectly level. For general instruction as to location, see page 496. The manufacturer suggests a suitable support of heavy timbers or of concrete, its top about 20 inches above the floor line. If the base be of concrete it should have a carefully leveled wooden platform on top, to which the machine may be attached by lag screws of suitable size, though they should not be pulled down too tightly. The manufacturer recommends mats of rubber, felt or cork under the feet of the machine, to absorb vibration and thus secure quietness of operation.

CAUTION.—If the top of the base be not perfectly level, then bolting down the bedplate of a 4-bearing Actodector may pull the machine elements out of line with each other, which will cause the coupling to wear rapidly. When installing be sure the bedplate is level.

WIRING.—The generator wiring diagram is shown in figure 169. You have only to follow it faithfully, observing Underwriter's Rules and the local laws. The manufacturer recommends that connections be made by a competent electrician.

BEFORE STARTING THE MACHINE.—After installation and conections are completed, see to it that everything is clean around the commutator, armature and motor rotor, that the armature shaft turns freely, that bearings are properly lubricated and that the brushes are under proper tension and move freely in their holders.

Close switch and observe whether armature revolves in the direction of the arrow on the generator frame. If it does not, then, if the current be 3-phase, interchange connections of any two of the wires. If it be 2-phase, interchange the connections on either phase. Single phase will always cause the armature to rotate in the right direction.

See that your positive wire attaches to the upper carbon.

OPERATION.—With projector table switches open, close motor switch, which starts the Actodector. Adjust field rheostat by means of panel control handle until voltmeter shows 70 volts.

Close projector table switch and strike arc. Adjust ballast

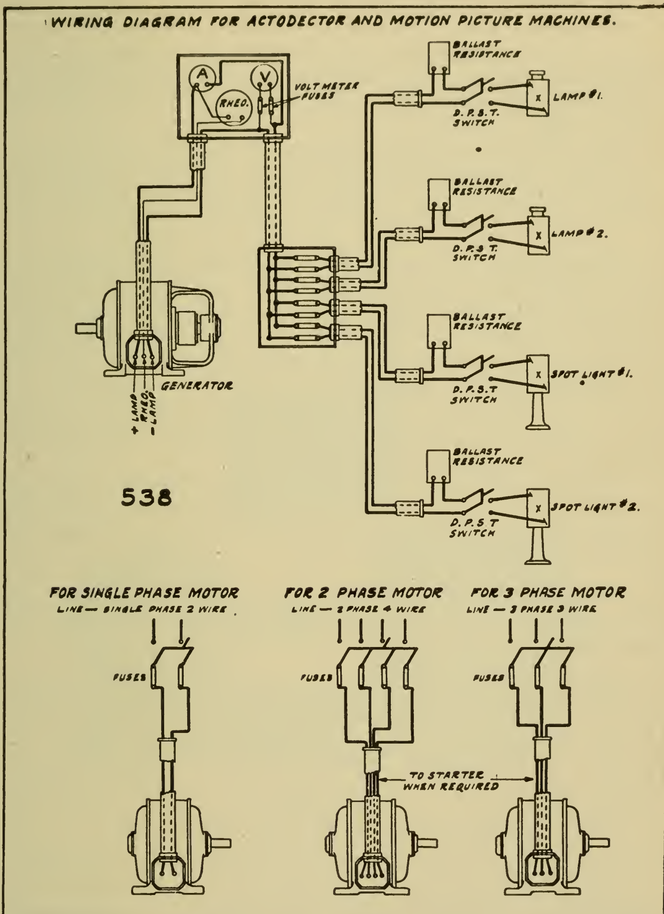


Figure 169

rheostat until desired amperage is obtained with arc burning at the length you find gets best results in light upon the screen, meanwhile maintaining 70 volts on the voltmeter by means of generator field rheostat.

The second arc may be put into operation in exactly the same manner, since they are in multiple, with ballast resistance, hence to all intents and purposes are operated entirely independent of each other. Either arc may be cut off without interfering with the other. To do so merely open the projector table switch.

Note.—During the first two hours of operation the Actodector heats up gradually to its normal operating temperature, which may necessitate a slight readjustment of the field resistance. This must be done with one lamp burning.

LUBRICANT.—The manufacturer recommends Texaco No. OO, Standard Oil Superba No. 57, or that you use Alemite or some equivalent grease for ball bearings. Twenty-five ampere Actodector ball bearings should not be lubricated too often or too liberally. Once a month in normal operation is quite sufficient. After the first month of operation, and thereafter every six months, all bearings should be cleaned out, flushed thoroughly with kerosene, rinsed with clean oil and given fresh lubricant.

Machines equipped with sleeve bearings should be oiled with a good grade of light engine oil. **Never** fill oil wells when machine is running. Every six months wash all bearings out thoroughly and fill with fresh oil.

IN ORDERING BRUSHES, always place number of machine found on name plate—on order. Order brushes from your dealer.

REMOVING ARMATURE.—Should it become necessary to remove armature, first remove all brushes from brush holders. Remove the screws holding the two bearing housings to the brackets. Remove the four nuts holding the motor end bracket. Remove motor bracket. Remove motor frame, permitting spacing ring between motor and generator to remain in place. You may then readily remove the armature, but be very careful that you do not bruise its windings, or lay them down on anything which can injure them. The replacement of the armature is, of course, merely a reversal of the process just described.

TO INSTALL NEW BALL BEARINGS, remove the armature as per previous instructions. Unscrew the lock nuts from its shaft, whereupon the bearings may be removed. In installing the new bearings, be very certain that the bearings and oil retaining rings are replaced precisely as the old ones were. Failure to do this will result in trouble, with probably ruined bearings.

TO REMOVE ARMATURE FROM 3-bearing or 4-bearing machines, first loosen the generator half of the shaft coupling, then remove all brushes from their holders, but do not loosen their pigtails. Remove bolts in outside generator end bracket. Disconnect any wires that may be necessary in order to remove the bracket, being sure to tag all wires when you disconnect them, so that you may get the conections made again correctly. You may then remove the armature.

ADJUSTING METERS.—If you have good reason to believe the meters are not registering correctly, have them tested. If they cannot be tested and adjusted or repaired locally, then send them to the factory.

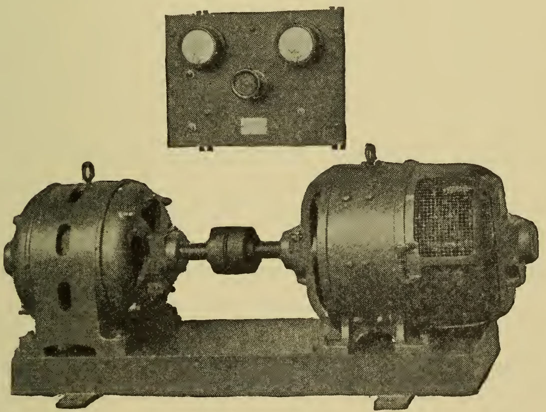


Figure 170

General Appearance of Roth 4-Bearing Actodector

IMPORTANT.—When writing the factory concerning any trouble always include this information: (A) Serial number of the machine, (B) Power line voltage at **motor switch** when motor is pulling its full load. (C) Speed of armature shaft at no load and at full load. (D) Volts and Amperes which can be obtained from the generator. (E) **Complete description of the trouble.** If you cannot yourself gives answers to above questions, then get an electrician to supply them. In order to be sure to correctly diagnose the trouble the manufacturer

must have **all** this information. If you do not supply the full information you must expect delay and probable failure to get much satisfaction from the manufacturer until you do.

The most common causes of troubles are (1) Commutator trouble. (2) Brushes. (3) Bearing trouble. (4) Low or variable supply voltage. (5) Wires too small or poor connections or grounds. (6) Noisy operation due to machine out of line or not set level or poor foundation. Motor air gap not equal all the way around motor rotor. Bearings loose in housing or shaft. Shaft sprung or armature out of balance.

COMMUTATOR.—The brush position is correctly set at the factory and **must not be changed, except upon advice from the factory.** Possible commutator troubles are many. They are fully dealt with under general instruction No. 7, page 502. Cutting or roughing of the commutator may be caused by (a) Hard brushes having too much tension. (b) Brushes which have dirty faces, possibly with a too-heavy tension. An armature shaft which has no end motion at all. (d) Brushes which stick in their holder. (e) Brushes moved from their original position as determined at the factory. (f) Excessive brush tension. (g) Brushes not properly seated. (h) Excessive sparking at brushes. (i) Overloaded generator. (j) Eccentric commutator. (k) Brushes worn down too much. See General Instruction No. 7, page 502 and study all its various paragraphs.

NOISY, WORN OR HOT BEARINGS.—Sleeve Type Bearings: Lack of oil. Poor oil. Dirty oil. Oil used too long without cleaning bearings out and renewing oil. Oil rings not turning. Bearings out of alignment, which with 4-bearing sets is caused by motor and generator being out of line with each other, usually because the foundation top is not perfectly level. Misalignment of 2-bearing sets is usually due to feet being bolted to a base having uneven top.

Heating of waste-packed bearings indicates (a) Lack of sufficient oil. (b) Oil of poor quality. (c) Waste improperly packed around journal. (d) New waste packing required.

Ball bearings will run smoothly and noiselessly unless (a) There is lack of sufficient grease. (b) Grease used is too heavy. (c) Dirty grease. (d) Grease contains acid (usually sulphuric) which has roughened the surface of the balls or their races, or both. **Use recommended grease only.** (e) Flat spot on one or more balls. (f) Ball race loose in bracket housing, or on shaft. (g) Bearings improperly installed. Same corresponding lettering on both bearings must go either to the inside or outside of the housings.

BEARINGS LEAK OIL—CAUSES.—When sleeve type bearing leak oil it may be caused by (a) Oil ring has slipped from under retaining pin. (b) Overflow hole of well stopped up. (c) Oil wells filled too full. (d) Overflow cover stuck down. (e) Drain hole on inside end of bearing clogged up. (f) A sand hole in the bearing housing. (g) Bearing badly worn.

Ball Type: (a) Grease too thin. (b) Excessive greasing, so that grease is thrown out by centrifugal force. (c) Bearing housing or bearing excessively hot. Clean thoroughly with kerosene, flush with oil and apply fresh grease.

MOTOR DOES NOT RUN AT FULL SPEED.—(a) Low supply line voltage or wrong cycles. Causes motor to run slow and overheat. (b) Fuse of one phase blown. (c) Wrong connections to motor. 220 volt motor connected on 110 will run slow and may overheat. 110 volt motor connected on 220 will either blow fuses or overheat. (d) Motor rotor and generator armature rotating in wrong direction.

Line voltage **must** be as specified on name plate; also cycles if it be an A. C. motor.

If motor operates alright for several hours and then gradually looses speed, and you can find none of the trouble hereinbefore described present, then the cause most likely lies in the motor rotor or stator. Repairing is the only remedy.

LOW GENERATOR VOLTAGE may be caused by (a) Insufficient speed. (b) Fault in commutator. (c) Poor or dirty brushes, or lack of sufficient brush tension. (d) Wrong make or type of brush. (e) Loose pigtails. (f) Loose or corroded joints in wiring or on generator.

ALL WIRE splices must be so soldered that the wires are perfectly electrically bonded. All wires must have sufficient capacity, see Table 1, page 70. All switches must have sufficient capacity to avoid excessive resistance. **If in doubt play safe and install a too-large conductor,** rather than one to small.

MACHINE OPERATES NOISY.—(a) Worn bearings. (b) Bearings improperly installed or defective. (c) Machine not set level. (d) Air gap not equal all the way around motor rotor. (e) Bearings loose in housing or on shaft. (f) Shaft sprung or armature out of balance.

An unequal air space between rotor and stator of 2-bearing sets may be corrected by loosening the nuts holding the motor and bracket. Using a feeler gauge between rotor and stator, gradually tighten bracket nuts until air gap is equal all the way around.

RHEOSTAT TROUBLES.—If rheostat fails to change amperage when adjustment is altered, it may be because of (a) poor contact of moving arm with contacts. Contacts may be dirty or corroded, or adjusting handle slipping on adjusting rod. (b) Poor conections somewhere in the instrument, or a badly burned wire. Examine the rheostat once every three months and make sure it is in good condition.

WARNING.—Because of the fact that the Actodectors supply low voltage, it is especially important that the motor run the generator at full speed, therefore examine all connections from main house switchboard to motor periodically making sure they are all tight and in perfect electrical condition.

Approximate Weight and Dimensions of ACTODECTORS

"Double Rated" ACTODECTOR

Ampere Rating	Weight	Width	Length	Height
25-25 polyphase	300	15	26	13
25-25 single phase	405	21	41	16¾
35-35 polyphase	570	21	41	19
50-50 polyphase	700	21	49	21
75-75 polyphase	850	21	54	21½
100-100 polyphase	1300	25	59	23

"Single Rated" ACTODECTOR

Ampere Rating	Weight	Width	Length	Height
100 polyphase	1300	25	59	23
150 polyphase	1800	24	67	27
200 polyphase	2000	24	70	27
250 polyphase	2400	26	77	29
300 polyphase	2800	26	80	29

"Double Rated" 3-Bearing Type ACTODECTOR

Approximate Dimensions of Instrument Panels for Double Rated Generators

Ampere Size	Voltage	Width	Length	Height
25-25	70	5″	14″	10″
35-35	70	5″	14″	10″
50-50	70	5″	14″	10″
75-75	70	5″	19″	14″
100-100	70	5″	19″	14″
For Single Rated Generators				
100	100	21″	30″	24″
150	100	21″	30″	24″
200	100	21″	30″	24″
250	100	21″	30″	24″
300	100	21″	30″	24″

THE WOTTON VERTICAL REXOLUX.—This machine is made by the Electric Products Company, Cleveland, Ohio. It was the first vertical type (armature standing on end) motor generator set used for motion picture projection work. The Rexolux receives A. C. at line voltage, and delivers D. C. to the arc, at arc voltage, without resistance in series and the loss incident thereto.

The machine is built in three sizes, viz.: One designed to operate a single lamp; one to operate two lamps alternately, and one to operate two lamps continuously. Where two lamps are operated continuously, only the 70 ampere machine is available.

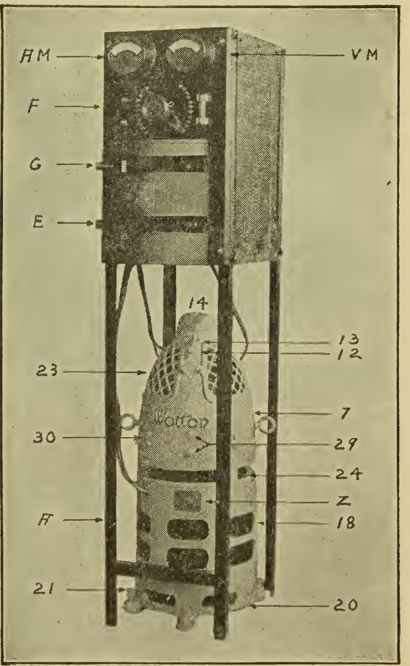


Figure 177.

The 50 ampere machine, of either MA, or twin type (the meaning of these different types will be explained later on) occupies a floor space 17 by 20 inches, and has a vertical height of 34 inches, to the top of cap 14, P. 1. The switchboard, supported by angle irons, is immediately over the machine, so that the entire space required for the 50 ampere equipment is 17 by 20 inches on the floor, by 5 feet in vertical height. The

35 ampere machine is 3 inches less, and the 70 ampere is 3 inches greater in height, but the floor space required is practically the same for all the types.

In referring to ampere capacity the ratings are based on continuous operation. The 35 ampere machine will carry 5J amperes, the 50 ampere machine 70 amperes and the 70 ampere 90 amperes for short periods of time. This means that these machines will carry full load continuously, and stand the overload named for short periods, say not exceeding two or three minutes.

These machines are built for all standard voltages and frequencies, viz.: 110, 220, 440, and 550 volts; 25, 30, 40, 50 and 60 cycles, single, two and three phase.

CONSTRUCTION.—Referring to Plate 2, Fig. 178, it will be seen that the machine consists of four main castings, viz.: Base casting 20, which rests directly on the floor and

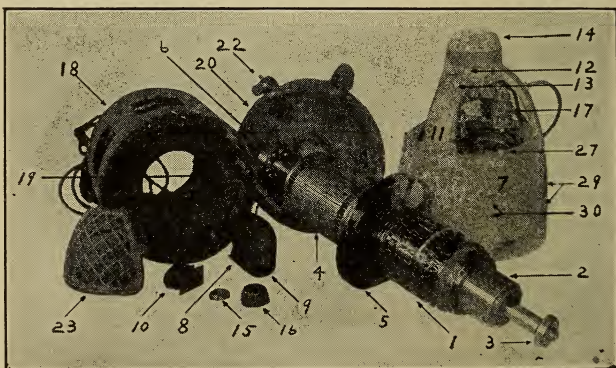


Plate 2, Figure 178.

contains in its center the cup or depression carrying ball race 6, which supports the entire armature; casting 18, which rests on base 20 and forms a housing for the alternating current driving motor, the detailed construction of the windings of which are plainly seen at 19, Plate 2; main upper casting 7, which supports the pole pieces of the D. C. generator, and upper yoke casting 11, carrying grating 23, the upper armature bearing, and cap 14, Plate 1; main upper casting 7, Plate 2, and yoke castings 11, Plate 2, are held together by bolt 27, Plate 2, dividing at the dotted line.

The armature stands vertical (on end), with the rotor of the alternating motor, 4, Plate 2, below, fan 5 above rotor 4, and armature 1 with commutator 2, above the fan. The upper end is supported laterally by a ball bearing, the construction which is shown in detail in Plate 3, Brush holders and brushes 17 are shown in Plate 2.

The details of upper bearing 3, Plate 2, are shown in Plate 3, in which 4 and 5 are, respectively, an exterior and interior ball race, separated by steel balls 6, part 5, the interior race being clamped rigidly to shaft 9, by means of nut 2. Part 4 is stationary and sets in a recess in the main frame casting,

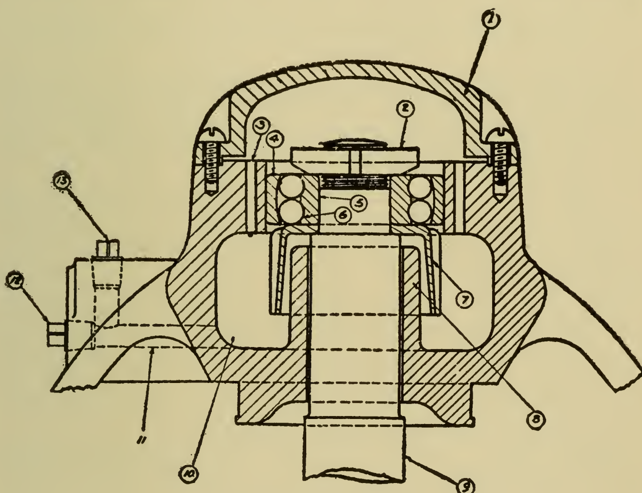


Plate 3, Figure 179.

the whole being covered by cap 1. Part 7 consists of a casting which is clamped between interior ball race 5, and the shoulder of shaft 9, so that it must revolve with the shaft at armature speed. This part (7) extends down into oil well 10. The oiling action is as follows: Oil well 10 is filled with oil up to approximately one-quarter inch of the top of the passage containing plug 13. Part 7 revolves at high speed, and, by the centrifugal action thus created the oil is forced up through passage 3-3, whence by gravity it returns again to the well through the bearing, thus flooding balls 6 with a continuous stream of oil.

Thirteen, Plates 1, 2 and 3, is a plug closing the passage through which oil well 10 is filled. **It is essential that this plug be in place and screwed tightly home, else the centrifugal action before named will force the oil out and empty the well.** Plug 12, Plates 1, 2 and 3, is for the purpose of draining oil well 10, and **this should be done at regular intervals every thirty days.** After draining the oil well insert plug 12 and fill the well with kerosene, start the machine and let it run for, say, two minutes, after which drain all the kerosene out, replace plug 12 and fill the well up with lubricating oil to within one-quarter inch of the top of the passage stopped by plug 13.

As the quality of oil to be used, see General Instruction No. 3, but:

CAUTION.—Never, under any circumstances, use the much advertised patent oils, as they almost without exception are worthless for the lubrication of heavy or high speed machinery. The use of such oils will invalidate the manufacturer's guarantee.

On the other, or lower end of the armature shaft, is ball bearing 6, Plate 2, lubrication for which is furnished by grease cup 21, Plates 1 and 2. This grease cup should be kept filled with Alco Grease.

CAUTION.—It is important that either Alco Grease or some other high grade cup grease be used, because of the fact that if a grease containing any acid is used in cup 21, the acid will attack the steel balls, and in course of time destroy their accuracy, thus compelling an unnecessary and somewhat expensive renewal of the bearing.

ARMATURE.—The armature or revolving member of the machine is completely assembled into one solid part, 1 to 6, Plate 2, in which 3 is the upper and 6 the lower bearing. The alternating current rotor, or revolving member, 4, is built up of reannealed electrical sheet steel, properly punched and assembled on armature shaft 9. The rotor bars are driven through the slots a tight fit, the ends electrically welded together into a solid mass of pure copper, which insures perfect contact, low resistance and a uniform torque, or pulling force. Directly above the rotor is fan 5, Plate 2, made of sheet steel blades and a solid ring, the blades riveted and welded together, and finally attached to shaft 9 by means of two heavy set screws. This fan produces a suction through the ventilating openings in castings 18 and 20, drawing cold air over the windings of the A. C. motor. This air is then forced up over this D. C. armature, and out through openings 23, Plate 1.

Part 1, Plate 2, is the D. C. armature, which is mounted directly above fan 5. Armature coils are fixed in place with retaining band wires where the connections are made to commutator 2, Plate 2. The commutator is made up of hard drawn copper segments, insulated with mica, and held in place with steel rings clamped with four bolts. The D. C. generator is of the four-pole type, and is provided with commutating or inter poles.

BRUSHES.—The setting of the brushes is shown in Plate 4. There are four brush studs, 17, Plate 1, and two brushes to a stud. These brushes are attached to the holders by copper "pigtails." Particular care should be exercised to see that the screw holding the pigtail to the brush holder is kept set up tight, because unless the pigtail makes good contact with the holder, the tension spring will be compelled to carry current, which would probably heat the brush spring and destroy its temper.

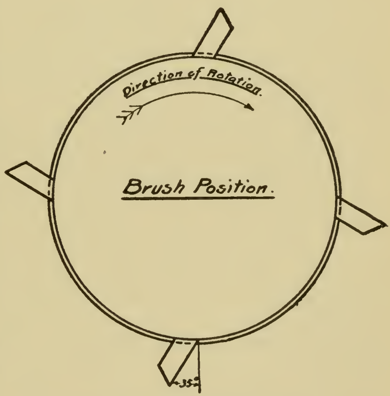


Plate 4, Figure 180.

With regard to the amount of tension the brushes should have see General Instructions No. 7.

The brushes are held in place by a curved arm passing around the holder, ending in a tension finger fitting on the top of the brush. The brushes are held to the commutator **against** the direction of rotation. The amount of tension can be adjusted by the spring and ratchet on the side of the brush holder.

CARE OF COMMUTATOR.—With regard to the care of the commutator, see General Instruction No. 7.

The A. C. driving motor is the induction type, and is built either for single, two or three phase current, but the same machine will not operate on different phases. All standard machines are built to operate on both 110 and 220 volts.

INSTALLATION.—See General Instruction Nos. 1 and 2.

The Rexolux is so built that it may be readily disassembled, since owing to its weight it would in many cases be difficult to hoist it in place in a projection room as a unit. In order to disassemble the machine, proceed as follows:

First, open gratings 23, Plate 1, and remove the commutator brushes from their holders, allowing them to hang by their pigtails so that you can make no mistake in getting them back into their proper holder. Remove screws 26, holding cap 14, Plate 1. Remove nut 2, Plate 3. Remove nuts 24, Plate 1 (three of them) holding main upper casting 7, and main lower casting 18 together. Thrust pieces of gas pipe or steel bars through the eye-bolts and lift main casting 7 straight up and off, laying it to one side, but right side up so that oil will not run out of oil well 10, Plate 3. Next carefully lift out the armature, first, however, having provided two blocks or chairs, and **lay the same down flatways on these blocks or chairs, so that the weight is entirely supported by the shaft.**

It is very important that you do **not** lay the armature down so that it rests on the side of the alternating current rotor 4 fan 5, or direct current armature 1, or commutator 2, since any injury to these would be a very serious matter indeed Handle the armature carefully and use a little good sense if you wish to avoid trouble. The machine may now be hoisted or carried into the projection room, where its reassembling will merely be a reversal of the process of disassembling. First carefully lower the armature into place, being careful that alternating current rotor 4, Plate 2, be on the lower end. Next replace casting 7, and tighten up nuts 24, Plate 1, tight. Replace top ball races and nut 2, Plate 3, **tightening nut 2 down as tight as you can get it.** Replace cap 14 and screws 26. Rotate the armature by hand to see that it turns freely, after which replace the brushes in their holders, put gratings 25, Plate 1, back into place, and the job is done.

Be sure and wipe the inside of the top casting clean, since if any oil should get on it, it would collect the copper dust from the commutator and might cause a ground on the brush yoke. See that the casting and brush yoke are thoroughly cleaned of all oil and dust before it is put back in place. It would be preferable to wash them with a cloth dipped in gasoline, wiping with a clean, dry cloth afterward.

Bolts 29, Plate 1, hold pole piece 8, Plate 2, which carries coil 9, Plate 2, in place, and should not be removed under any circumstances, unless the coil be damaged and require rewinding. There are four of these pole pieces and eight bolts, two bolts per pole piece. Bolts 30, Plate 1, hold inner poles 10, Plate 2, in place, and should not be removed under any circumstances unless the coil is burned out and requires rewinding.

Remember the switchboard sets directly over the machine, as shown in Plate 1. With each machine there is furnished three cork pads, 2 inches square by 1 inch thick, which are to be placed under the feet of the machine, where they act as a cushion, absorbing noise and vibration. It is not necessary nor do we recommend screwing the machine to the floor with lag bolts. Its weight is sufficient to hold it in place.

ELECTRICAL CONNECTIONS—TYPE MA SINGLE ARC REXOLUX

In Plate 5, lines G-G show the direct current circuits. The current from the positive generator brush passes out at + G, thence over the evenly dotted line to switch B (G, Plate 1), which when closed, connects, after passing through the ammeter, with the positive carbons of the arc lamp. From the negative brush of the generator the current passes through the various interpole coils in series, then out at — G, thence similarly up to the negative side of switch B, and thence to the arc. In order to obtain the necessary field regulation, the extra lead from the shunt field is brought through the frame at F, Plate 5, and thence up to the field regulating resistance. The voltmeter is connected across the terminals of the arc at the right hand side of switch B. This completes the direct current connection for the type MA single arc Rexolux.

Were it not necessary to obtain a self-starting motor, in single phase machines, it would then require but one set of windings. In order, however, to obtain the necessary starting torque, a second set of wire coils is superimposed upon the main power coils. This set of starting coils is thrown out of phase with the power coils by inserting in series therewith a starting resistance and reactance, shown opposite starting switch A, Plate 5. The main power coils terminate in the frame at "M1" and "M2," Plate 5, and the terminals of the extra starting coil at T, the other end of which is connected inside of the machine to the main power coils. The lines designated by a dash and a dot constitute the alternating current wiring of the system.

Where two or three phase current is supplied it is not

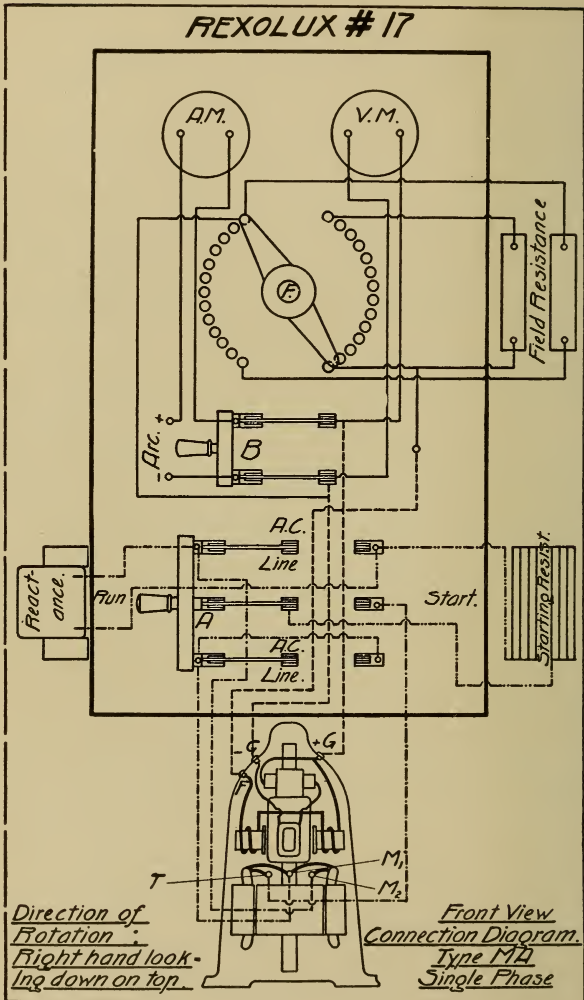


Plate 5, Figure 181.

necessary to use the extra starting coils, or the starting resistance or the reactance. In this case the wiring incident to the starting features of the single phase motor is omitted.

TWO ARC, TWIN TYPE REXOLUX.—The twin type applies to all of those equipments wherein two separate motor generators are used for two projection arcs. Each motor generator is continuously operated independently of the other. Each motor generator is connected to its own projector.

Wherever it is desirable to secure double the capacity of

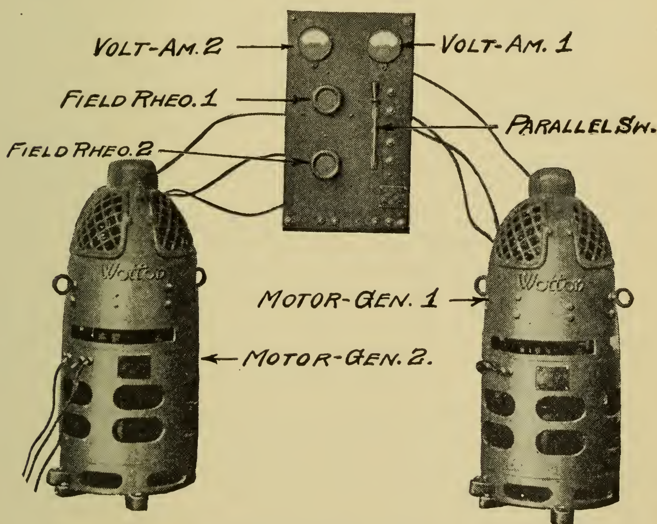


Plate 6, Figure 182.

one machine, the two motor generators can be operated in parallel by closing the paralleling switch. In case one of the motor generators for any reason is out of commission, the two projectors can be temporarily handled by the remaining machine by stealing the arc from one to the other during the change over. By means of these two independent units, one reel can be perfectly dissolved into the other without in any way affecting the picture on the screen. In the operation of the twin type there are no switches on the control panel which need to be opened or closed during the change from one reel to another, or at any other time during the performance, except at its beginning and end. One machine naturally will be running idle while the arc to which it is attached is dead. The actual current consumed by this machine is approximately 350 watts. The opening of the projector table switch not only disconnects the generator from the arc, but opens the field circuit of the generator as well. There is no change over resistance loss with the twin type.

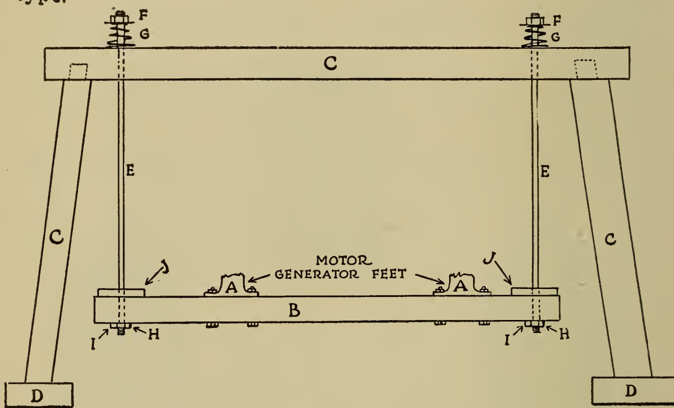


Figure 181-A

Cut of Platform to absorb vibration of motor generator set and prevent it from communicating to the floor and walls of the building.

B is a 4" x 6" timber (two of them) of suitable length. These timbers are joined by cross pieces J, J. C, C, C and D, D is a frame to carry platform, B, J, by means of iron rods and springs. E, E and G, G. The springs should be rather long and not too stiff. Harley-Davidson motorcycle front fork springs should serve very well, or sufficiently heavy diamond shape buggy or auto springs would serve perfectly.

WARNING—It is essential the platform, B, be tested with a level about once a week and kept perfectly level by means of nuts F, F.

TOO MANY MEN HAVE A WISHBONE INSTEAD OF A BACKBONE.

Mercury Arc Rectifier

THE mercury arc rectifier is a device marketed by two manufacturers, the General Electric Company and the Westinghouse Electric and Manufacturing Company. Its purpose is to change alternating current of standard line voltage to direct current at arc voltage, the reduction in pressure being accomplished by means of an auto-transformer, which is an integral part of the machine.

Kindly understand that we have, to some extent, sacrificed strict technical correctness to "understandableness" in the following:

PRINCIPLE OF OPERATION.—The mercury arc rectifier consists essentially of a sealed glass bulb, from which the air has been exhausted, provided with four terminals, A, A1, B and C, Fig. 183. Within this tube is a quantity of mercury, the purpose of which will be explained further on. The two upper terminals A. A1. Fig. 183, are of graphite or other suitable material, the two lower ones B, are of mercury, C, Fig. 183, which is the smaller of the two, being what is known as a "starting terminal." When the bulb is in a vertical position the pools of mercury in terminals B and C are separated, but when the tube is tilted or rocked sidewise to the left, they are brought temporarily into contact, for the purpose of putting the tube into action.

When in its active state the vacuum bulb contains vapor of mercury, which is a conductor of electricity only under certain conditions. Current will readily pass from graphite terminals, A or A1, Fig. 183, into the mercury vapor, and when the arc is burning and the circuit thus completed, will pass from it into mercury terminal B, and thus on through the arc.

Alternating current, however, changes its direction many times a second, and when the direction of flow seeks to reverse itself and pass from the mercury to the graphite terminals, the mercury vapor offers sufficient resistance to prevent it. The mercury vapor thus acts as a check valve, permitting the current to pass from the graphite into the mercury vapor, into the mercury and on throught the arc, but preventing it from reversing its direction and passing into the graphite terminals.

The A. C. supply circuit is connected to graphite terminals A and A1, Fig. 183, through an auto-transformer, which lowers or raises the voltage to that required at the arc, and as the above described action will only allow current to flow in one direction, the pulsations of current which pass alternately from terminal A and A1, Fig. 183, into the mercury vapor must, of necessity, all pass out of the vapor through mercury terminal B, Fig. 183, which is connected to the arc lamp. As a result the arc receives a continuous, slightly pulsating current which differs but little from ordinary D. C. Ordinarily the pulsations would be quite pronounced, but this is prevented by a feature of the auto-transformer (main reactance) which decreases them to such an extent that the current delivered at the arc has a very nearly constant potential value.

Before the bulb starts working it contains no mercury vapor. Within the bulb is a vacuum which must be filled with mercury vapor before current can flow. Once the space is filled with mercury vapor, however, and current flow has been started, it will continue to flow as long as it is uninterrupted, but any interruption, even for the shortest period of time, permits the vacuum to re-establish itself and stops the operation of the bulb.

HOW THE BULB IS STARTED.—In order to fill the bulb with mercury vapor, it is tilted until the mercury in terminals B, C, comes into contact, and since terminals B and C have direct connection with the A. C. supply, through a special circuit, current flows between terminals B and C. The tube is then rocked back to upright position which breaks the mercury bridge thus formed between terminals B and C, and in breaking it forms an arc or spark, which creates the initial current-carrying mercury vapor, and puts the tube into operation.

The alternating current supply circuit is connected to an auto-transformer, or main reactance, the terminals of which are conected to the terminals A, A1, Fig. 183. From terminal B the current passes through the projector arc, and the circuit is completed through a connection to the middle point of the autc-transformer.

The principal parts of a rectifier are: (A) an auto-transformer; (B) a regulating reactance coil; (C) a tilting mechanism; (D) a relay; (E) a dial switch; (F) a switch or other means for connecting the auto-transformer directly to the arc, and, (G) a bulb and its holder.

The reactance coil is for the purpose of steadying the arc, and limiting the current when the carbons are brought together when striking an arc, which is a dead short circuit, to a value which will not be injurious to the bulb.

Modern rectifiers are so equipped that in case the bulb gives out the projectionist can switch over to the auto-transformer and continue the show with alternating current, using the auto-transformer as an economizer. Also modern rectifiers are equipped with a dial switch by means of which the projectionist may instantly vary the voltage, thus varying the amperage within the minimum and maximum capacity of the bulb.

INSTALLATION.—Rectifiers are ordinarily received in two separate shipments, one of which, the rectifier itself, weighing several hundred pounds, will probably come by freight. The other, the glass bulb, carefully packed in a specially made case, is usually sent by express. In removing the bulb from its crate proceed strictly according to directions in loosening the crate, after which carefully lift out the bulb. It will be in an inverted position. Turn it slowly over and carefully let the mercury run down into terminals B, C. In rolling, the mercury should make a sharp, cracking sound, which is an indication that the tube is in good condition.

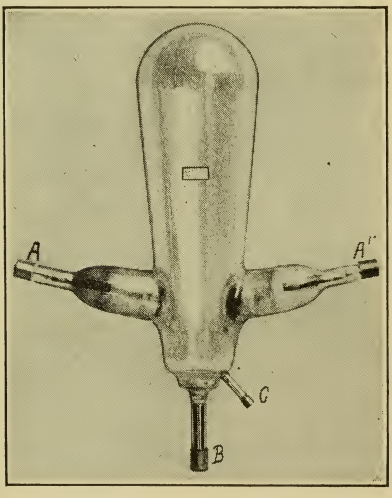


Figure 183.

The rectifier should not be located directly in the projection room, unless there be some means provided for covering the bulb so that its light will not shine in the room. Light in the projection room is highly objectionable. One very good method is to install the rectifier in an adjoining room and cut a space through the wall just large enough to admit the front panel of the rectifier. This allows the projectionist to have access to the switches for the purpose of varying the amperage, or changing over to A. C., and at the same time excluding the light from the room. Another way is to paint the bulb black, using lampblack ground in oil, thinned with turpentine. This does not in any way injure the bulb. It is in fact good for it as it will radiate the heat better.

There is but little sound from a rectifier except a humming sound which comes from the transformer. Care should be exercised that there is no sheet metal near the machine. If there is the magnetic action of the transformer will probably set up vibration therein, which will cause more or less objectionable noise.

VENTILATION.—There must be ample ventilation where the rectifier is located. Lack of ventilation will operate to greatly shorten the life of tubes.

CAUTION.—Tubes should never, under any circumstances, be operated above their maximum capacity.

COMPARATIVE RESULTS.—Experiments by Simon Henry Gage and Henry Phelph Gage, Cornell University, have shown that the losses through the pulsation of the current with the mercury arc rectifier are very slight. A mercury arc rectifier using 40 amperes at 52 volts gave 12-150 C. P., whereas straight D. C., 40 amperes at 51 volts, with the same carbon set, only gave 12,350 C. P., a difference of about 200 C. P.

On page 585 you will find a chart indicating the various troubles one is likely to encounter when operating a rectifier, together with the most probable cause or causes of each. We recommend a careful study of this diagram. With this chart and the detailed instructions contained in this book, plus a fair supply of common sense, I believe any projectionist ought to handle a rectifier without serious difficulty.

GENERAL ELECTRIC MERCURY ARC RECTIFIER.—The General Electric Company, Schenectady, N. Y., manufactures rectifiers for use on projection circuits in two capacities, viz.: 30 and 50 amperes.

Fig. 190 illustrates the design of the G. E. rectifier furnished for the first time in 1910. Several hundreds of these older rectifiers are still in service, and in response to many requests we are giving instructions on them. Cuts of the old rectifier are shown in Fig. 190. Diagram of connections is shown in Fig. 191.

The General Electric rectifiers may all be used on either 110 or 220 volts. They are made for all commercial cycles from 50 to 133, and for 25 to 40 cycle circuits. The late type G. E. rectifier is shown in Fig. 184. On the front of the panel are mounted the fuses, a three-pole, double-throw switch, the adapting links, the dial switch, and either an ammeter and voltmeter, or either one singly, these instru-

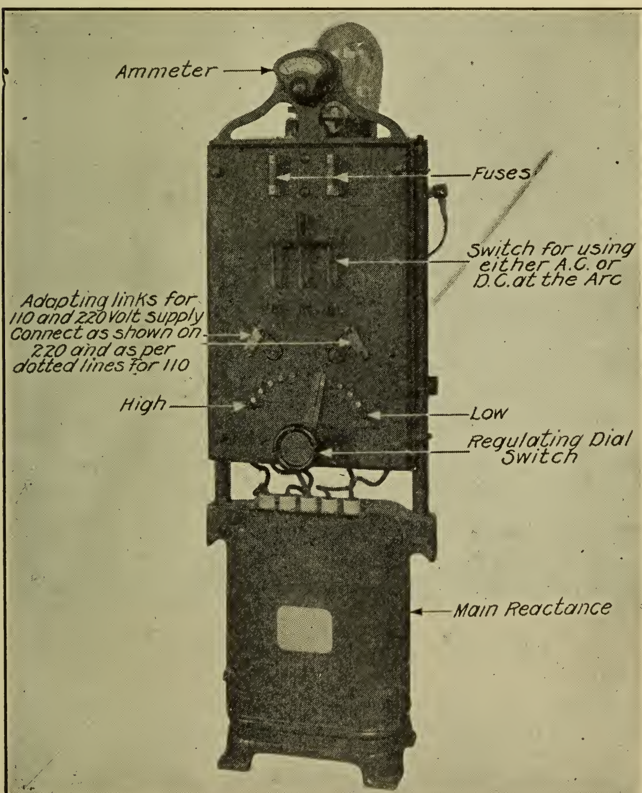


Figure 184.

ments only being provided when especially ordered. On the back of the board, or panel, are mounted the regulating reactance, the various relays, current limiting resistances, tube, etc., as in Fig. 185.

The machine is not excessive in weight, occupies but little floor space, and is entirely automatic in its operation. To

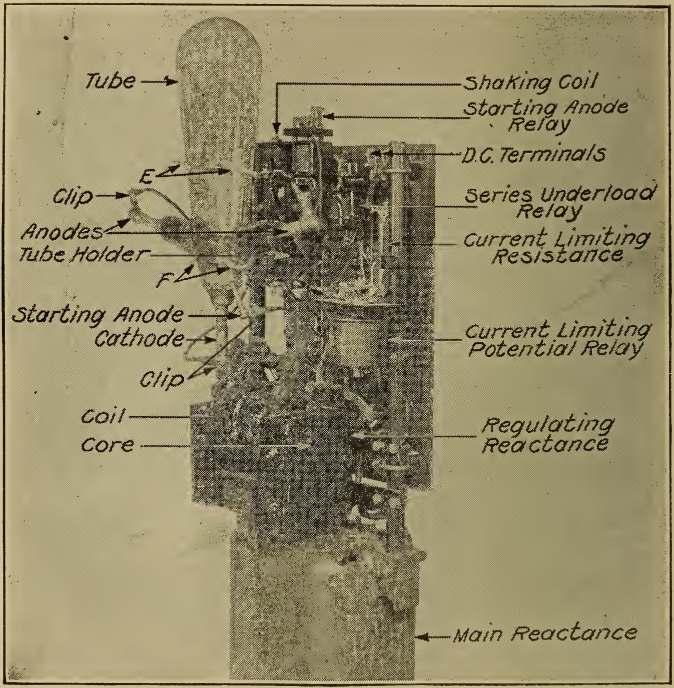


Figure 185.

start the rectifier, all that is necessary is to close the A. C. supply and projector table switches, and bring the carbons of the lamp together. The rectifier will then automatically start.

VOLT AND AMMETER.—The volt and ammeter (when ordered) are of the D'arsonval, or permanent magnet type.

They are accurate and are connected in the secondary, or D. C. side, hence show the voltage and amperage at the arc unless there is considerable drop between the rectifier and projector arc. **They should always be ordered when a rectifier is purchased.** The better practice is that they be mounted on

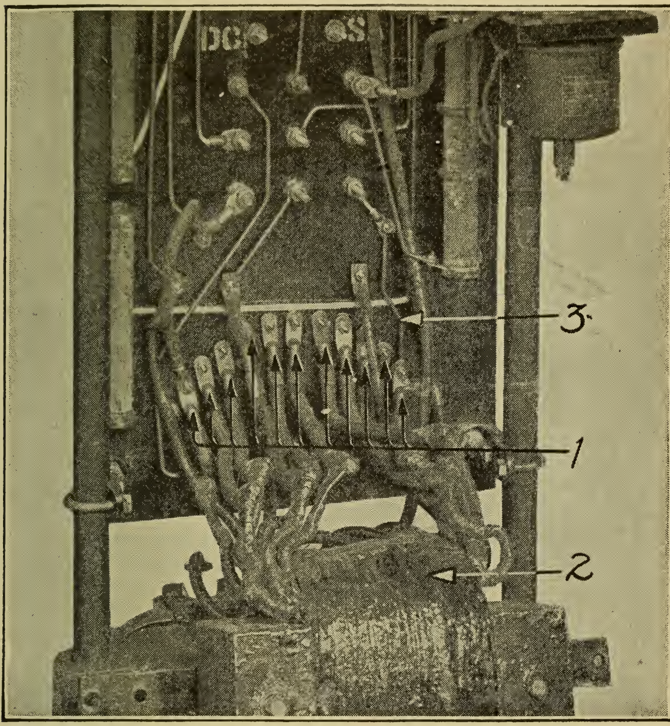


Figure 186.
General Electric Mercury Arc Rectifier

the wall in front of the projectionist, rather than on the rectifier, which latter, probably, will not be placed directly under the projectionist's eye. These instruments may be removed from the rectifier and so mounted if desired.

FUSES.—Fuses of greater capacity than those furnished with the rectifier should never be used. For a 30 ampere rectifier use 35 ampere fuses; for 40 or 50 ampere machine use 55 ampere fuses.

FROM DIRECT CURRENT TO ALTERNATING CURRENT.—In Fig. 184 we see a triple-pole, double throw switch in the center of the panel. By throwing this switch over the tube is cut out and A. C. direct from the lines is supplied to the arc, using the main reactance as an economizer. This is for use in case of accident to the tube. The switch as shown in Fig. 184 is set for D. C.

If the switch is thrown over to A. C. it may be found there is not sufficient amperage, in which case lead 3, Fig. 186, may be moved along studs 1, until sufficient current is obtained. Do not use more than 60 amperes, A. C. **The rectifier is built primarily for changing A. C. to D. C., and, while its main reactance may be used as an economizer, that provision is designed for emergency only.**

CONNECTING OR ADAPTING LINKS.—The connecting or adapting links, Fig. 184, enable the rectifier to use either 110 or 220 volt supply. To change from one to the other it is only necessary to change the connection of the links. For 220 volt supply they should be connected to the two upper and the two outer lower studs; for 110 volt supply connect to the two upper and the two inside lower studs.

THE DIAL SWITCH.—The dial switch has eleven contacts which are connected to eleven taps on the regulating reactance, Figs. 185 and 186. This connection may be examined in Fig. 186, in which the regulating reactance, 2, has been dropped down to show the connections. This switch enables the projectionist to regulate the amperage at the arc, and any amperage within the capacity of the rectifier may be instantly had by merely moving the switch to the left to raise, or to the right to lower, as per Fig. 184.

THE MAIN REACTANCE, Fig. 184, is nothing more nor less than an auto-transformer. It has three distinct functions, viz.: (a) It adjusts the voltage of the alternating current to the pressure necessary to secure the proper D. C. amperage at the lamp; (b) it supplies a neutral point between the alternating current lines and forms the negative of the direct current lines; (c) by its reactance it keeps the rectifier tube in operation while the current passes through the zero point of the alternating current wave.

THE REGULATING REACTANCE.—The regulating reactance, Figs. 185 and 186, is nothing more nor less than a choke coil, with eleven or more taps taken off at certain points along the winding. These taps are connected to an equal number of contacts of the dial switch, Fig. 184, so that the alternating current can be choked back or reduced to a value just sufficient to give the desired amperage at the arc.

Fig. 187 is a diagram of the connections of the General Electric mercury arc rectifier; all parts of the rectifier are shown diagrammatically **without reference to their actual**

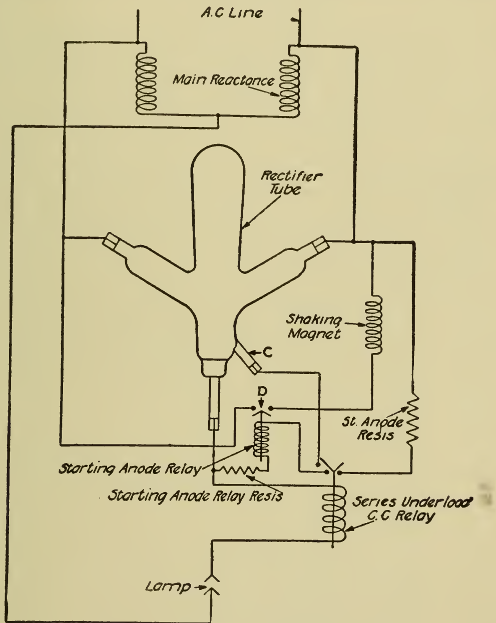


Figure 187.

position with relation to one another when mounted on the rectifier, the idea being merely to illustrate the method employed in starting. It will be seen that three coils are used for starting. viz.: A shaking magnet, a series underload relay and a starting anode relay, the latter, which is normally open, but picks up when the carbons of the lamp are brought together, thus closing the shaking magnet circuit (see D, Fig. 187), whereupon the shaking magnet pulls the tube over to one side, or, in other words, "rocks" it, thus allowing the mercury in cathode B, Fig. 183, to bridge over and form a connection with the mercury in starting anode C, which shunts the current from the starting anode relay D, Fig. 187, circuit, and operates to demagnetize its coil, thus allowing its plunger to fall and open the shaking magnet circuit, whereupon the tube, by its own weight, rocks back into vertical position, thus breaking the mercury bridge between anode C and cathode B. After the tube has started operating, and the arc has been struck, the series underload relay which is connected in the D. C. circuit picks up, thus cutting the starting anode relay and shaking magnet entirely out of circuit. If the tube does not start at once the shaking magnet will continue to rock the tube until it does.

INSTALLATION.—After the rectifier set has been uncrated and placed in its operating location (see "Installation," page 569), the tube should be placed in the holders E, F, as per Fig. 185. This is accomplished by pressing the narrow part of the tube, just above anode arms A, A1, Fig. 183, into upper clip E, Fig. 185, carefully lowering the tube until anodes A, A1, Fig. 183, rest on the lower clips, F, Fig. 185. Having the tube in place, you will find four wires covered with a sort of glass bead insulation, these wires terminating in brass spring clips, Fig. 188. Connect the two upper ones (either one to either anode) to anodes A, A1, the small lower one to starting anode C, Fig. 183, and the large lower one to cathode B, Fig. 183, as shown in Fig. 185. Next connect the A. C. supply lines to the two terminals, marked A-C, at the upper left-hand corner of the panel—that is to say, the left-hand corner as you stand facing the tube on the back side of the machine. Next connect the positive D. C. terminal, Fig. 185, marked + to one side of the projector table switch, and through the projector table switch to the upper carbon arm of the lamp, and connect the negative (marked) D. C. terminal to the other side of the projector table switch, and through it to the lower carbon arm of the lamp. Connect the adapting links in the front of the panel according to the voltage of your alternating current supply, as already directed. Having accomplished all this, with the triple-pole **switch closed in the upper position,** as per Fig. 184, and with the A. C. supply and D. C. projector table switch closed, the rectifier is ready to start.

OPERATION.—To start the rectifier bring the lamp carbons together, the tube will rock, and will either start or continue rocking. As soon as it starts, slowly separate the carbons to the usual distance for a D. C. arc. When the

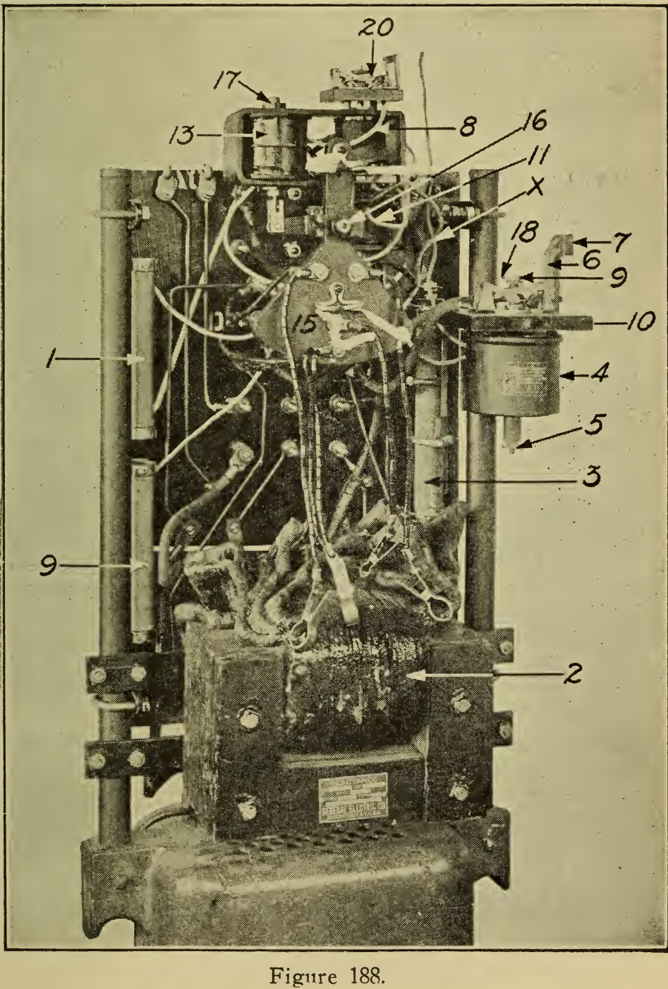


Figure 188.

carbons have been separated so that the voltage between them is about 45, the potential relay 4, Fig. 188 (if it is a 40 or 50 ampere rectifier; there is none on the smaller size) will operate and short-circuit current limiting resistance 3, Fig. 188, thus increasing the arc current to whatever value the dial switch is set for.

CAUTION.—When you first begin to use a rectifier be sure that the potential relay operates. If it does not, current limiting resistance, 3, Fig. 188, will heat, and while it would be difficult to actually burn it out, damage might be done to it or to the insulation of surrounding wires.

The projectionist can tell when this relay acts, as follows: When the carbons are first separated the current will be comparatively weak, but when the relay acts there will be a sudden increase in brilliancy at the spot. The knack of detecting the acting of the relay can be acquired by starting the arc several times and slowly separating the carbons until the relay picks up, having a man at the rectifier to tell you when it does pick up in case the rectifier is at a distance.

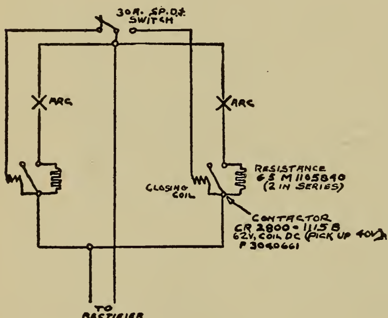


Figure 188a

To stop the rectifier, open the projector table switch, though opening either the switch on the A. C. lines or the triple-pole switch in the face of the rectifier panel will have the same result.

OPERATING TWO ARCS FROM ONE RECTIFIER.—When it is desirable to operate two arcs from one rectifier the General Electric Company will furnish two resistances equipped with contactors, one to be used in series with each lamp. These resistances consist of several tubes, capable of being mounted on pipe or flat surface.

Diagram, Fig. 188a shows the resistance connected in the lamp circuits. The operation of dissolving one reel into another is briefly as follows:

Assume the projectionist to be running a picture on the left-hand projector and approaching the end of the reel. He closes the carbons on the right-hand side, which permits enough current to flow through the resistor as the contactor is still open) to warm up this side while the other side is yet running. The resistors may need some adjustment to give proper warming up current. To bring the right-hand side into full operation he now throws the lever switch to same side. This closes the contactor, shorts out the resistances, and at the same time allows the contactor on left side to open, throwing a resistance in series with this arc. The arc probably will die out, but if not, the carbons can be separated slightly. To bring in the machine on left side, the operator brings the carbons together, and when ready throws switch to left, repeating the operations as for the right side.

We would most emphatically recommend to exhibitors the purchase of the large rectifier. Modern practice is to use high amperage and project a brilliant picture. The first cost will be greater, but it is well worth the money. This holds good even for the small towns, provided sufficient current is available to supply the large rectifier.

PRACTICAL OPERATION.—You need not be afraid to perform any of the various operations we shall describe in case of necessity. Just follow the directions and use a little common sense, remembering where each part goes, or better still, attaching a labeled tag to it as you remove it. **There is no mystery about these things. All too often the projectionist hesitates to attempt the making of repairs through fear of being unable to get the thing back into shape. The rectifier is strongly made; its parts are very simple. We repeat: Follow the instructions here given, supplementing them by ordinary common sense, and you will not be likely to have any trouble.**

Current-limiting resistance 3, Fig. 188, consists of a strip of resistance metal, wound in spiral form, covered with insulating material and supplied with contacts at either end. Resistances 1 and 9, Fig. 188, are of wire wound on asbestos, the whole dipped in an insulating material.

The purpose of current-limiting resistance 3, Fig. 188, is as follows: When the lamp carbons are brought together the effect is, to all intents and purposes, to form a short circuit, which would have the effect of sending a heavy rush of current through the arc circuit. **Resistance 3, Fig. 188, takes the place of the resistance the arc will offer after the carbons are separated.** This resistance is automatically cut into circuit when the plunger of relay 4, Fig. 188, is down; or, in other words, when relay 4 is "open." When the carbons are opened and the arc struck, the effect is to add the resistance of the arc to the resistance offered by current-limiting resistance, 3, and thus raise the voltage of the lamp circuit. When this voltage reaches a certain point (about 40

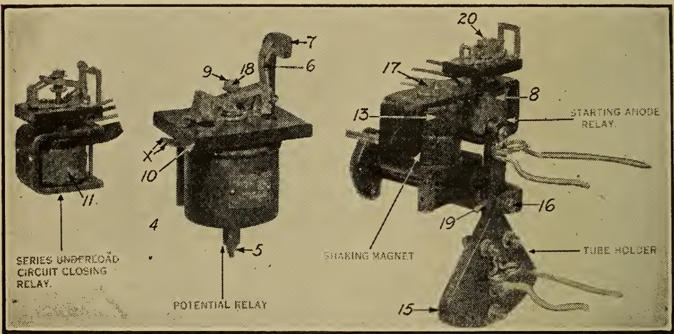


Figure 189

volts) the energy of the magnet of relay 4 becomes sufficient to raise plunger 5, Figs. 188 and 189, and bring blade 6, Figs. 188 and 189, into contact with block 7, Figs. 188 and 189, thus short-circuiting current-limiting resistance 3, and raising the D. C. amperage.

Should relay 4 at any time fail to act, it is likely plunger 5, Figs. 188 and 189, is stuck, which might be caused by a grain of sand, a bit of dirt or from some other cause. This plunger may be removed from the magnet by pulling out split key 18, Figs. 188 and 189, and, while holding stationary nut 9 at the top of the plunger, unscrew plunger 5 by turning its lower end. Having removed the plunger and ascertained the cause of its sticking it may be replaced, and when you are able to get split key 18 into its hole the plunger is in the proper location. **In replacing nut be sure to get it**

right side up. If you cannot get the split key in, the probability is that you have the nut wrong side up. Also, **in replacing nut 9, be sure to get the two washers underneath it in place.**

It will be well to clean the contact between block 7 and blade 6, Fig. 189, about once a month, using 00 emery cloth.

Should anything occur to seriously injure the parts on top of relay 4, Fig. 189, as for instance something falling on them and smashing the whole thing so badly that it could not readily be put back into shape, then new parts can be obtained from the factory. In order to remove the old parts, take out three screws in the top of block 10, Fig. 189, the same being countersunk into the block, two on one side of the brass parts and one on the other; disconnect the wires from the parts; take out plunger 5, as per former directions. You can then lift the block off and replace it with a new one. The block should be ordered complete, with the parts assembled. Should it ever become necessary to remove the coil of relay 4, Fig. 189, first proceed, as before directed, to remove block 10, Fig. 189, whereupon you will see three screws in the top of the coil casing. Remove them, disconnect the two wires which lead from the coil, and disconnect wires (two of them) X, Fig. 189. You may then lift the coil out, and replace it with a new one if necessary.

The instructions given for removing the top and the coil of relay 4, Fig. 189, apply equally to all the other relays; just remove the screws in the top of the block (the screws are, in all cases, countersunk), disconnect the wires, remove the relay plunger, and the whole thing comes off.

Resistance coil 9, Fig. 188, is connected in series with the contacts of series underload relay 11, Figs. 188 and 189. (You cannot see this relay in Fig. 188. It is under arrow head 11). This resistance is **not** in series with the relay coil, but serves to limit the flow of current through the starting anode, Fig. 185. But for this resistance the flow of current through the starting anode would be so heavy that there would be liability of damage to the tube.

Resistance coil 1 and 9, Fig. 188 may be removed simply by pulling them out of their clips as you would a cartridge fuse. Resistance coil 3 may be removed by disconnecting the wires attached to it, and taking out the screw which holds the carrying clip to the panel.

SHAKING MAGNET.—The action of the rectifier is made automatic by means of shaking magnet 13 and relay 8, Figs.

188 and 189. These magnets are therefore very important. Part 15, Figs. 188 and 189, is so made that it brings the tube back to the vertical position after it has been rocked by the action of the shaking magnet, through force of gravity. Should the tube at any time fail to rock to the vertical position, it is most likely due to friction in spindle 16, Figs. 188 and 189. This friction may be overcome by means of a drop or two of oil on the bearing surfaces, just behind the nut on the end of the bolt, and at the back of the spindle. It is also possible that dirt may work in beside plunger 17, Figs. 188 and 189. This plunger may be removed by taking out the bolt in the fork at its lower end, and driving out the small pin in nut 17 at the top of the plunger. The plunger can then be dropped down enough to clean it.

Should plunger 20 of relay 8, Figs. 188 and 189, fail to work, it may be taken out and examined by removing the split key at its upper end and pulling the plunger out at the bottom.

Should the rectifier at any time fail to act, the very first thing to examine and test will be your fuses, including those on the front of the panel. Don't try anything else until you have **tested** the fuses. **It is quite possible you may get a spark at the carbons of the lamp when one of the fuses is burned out.**

ORDERING RENEWAL PARTS.—Almost every projectionist will, sooner or later, find it necessary to replace certain parts of the rectifier equipment that wear out from usage.

IMPORTANT.—To insure correct filling of orders for such parts it is essential that the following information be given with each order:

1. Catalog number and

2. Serial number of complete rectifier equipment. (These will be found stamped upon name-plate attached to front of rectifier panel.)

3. Catalog number, specification or any distinguishing mark that may appear on the part wanted.

3A. If no marking can be found, describe the part as clearly as possible. An accurate pencil sketch of the part helps, too.

4. Quantity of each part wanted.

The order should then be forwarded to the nearest sales office of the General Electric Company, or direct to its General Offices at Schenectady, N. Y.

OLD STYLE MERCURY ARC RECTIFIER.—The following information is prepared for the convenience of projectionists using G. E. Rectifiers of the design furnished prior to 1918, many of which are still in use, particularly in the west.

Before putting this information to use it is well to compare your panel with illustrations shown in Fig. 190 and to determine whether they correspond.

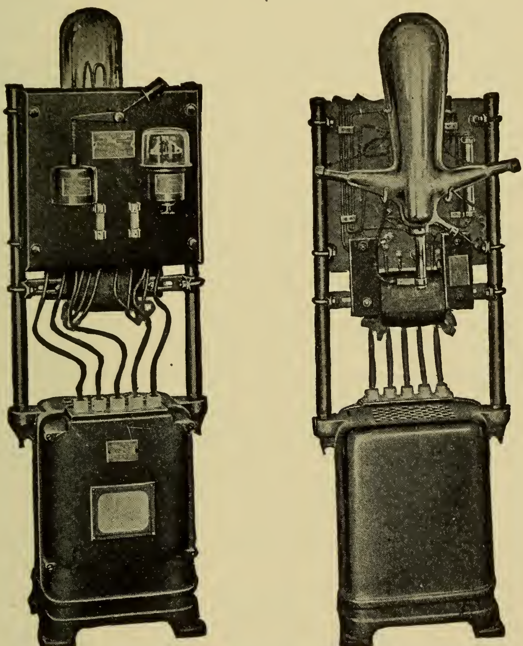


Figure 190.

1. The leads marked "AC" should be connected to the lower studs of a double-pole single throw switch located near the motion picture projector. The upper studs of the switch should be connected to the "AC" source of supply.

2. The leads marked + and — should be connected respectively to the positive (upper) and negative (lower) carbons of the motion picture lamp.

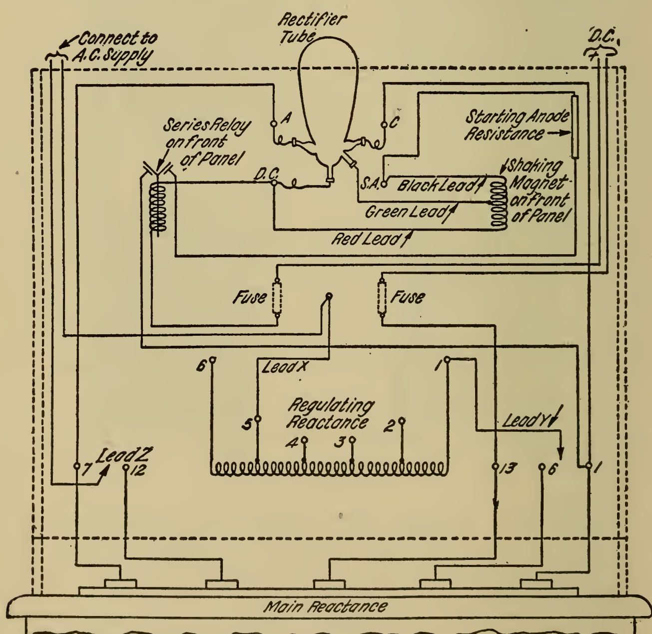
3. If the "AC" supply voltage is 110, then connect the

flexible lead marked "Z" to stud marked 12, and flexible lead marked "Y" to stud marked 6 on main reactance.

If the "AC" supply voltage is 220 volts then connect lead "Z" to stud 7, and lead "Y" to stud 1 on main reactance. Note: do not disturb the other connections that are made on studs 1, 6, 7 and 12 of the main reactance, but only place leads "Y" and "Z" as directed.

4. The tube holder should be reversed so that the clip and support will be turned away from the panel instead of towards the panel, as it is when shipped.

WIRING DIAGRAM FOR OLD STYLE RECTIFIERS.— 5. Remove the tube from its box, being very careful not to handle it roughly, nor to strain the seals in any way whatever. Care must also be taken to prevent the mercury from suddenly flowing into any of the arms, otherwise the



Back View of Rectifier Panel Showing Wiring

Figure 191.

RECTIFIER TROUBLE CHART.

- **TUBE DOES NOT START.**
  - See if there is voltage and if it is up to normal.
    - **TUBE DOES NOT TILT.**
      - No current at tube terminals.
        - Current at switch—Fuses blown.
        - No current at switch—Line voltage off.
      - Relay contact not closed.
        - Friction or bent stud.
        - Relay contact is poor.
        - Tilting circuit open.
        - Secondary coil of magnet short circuited.
    - **TUBE TILTS.**
      - Amalgam bridge between electrodes—Install new tube.
      - D. C. circuit open.
        - Lamp circuit open.
        - Carbons not making good contact with each other or with the lamp jaws.
- **TUBE TILTS**
  - Does not return to vertical.
    - Lead on starting anode broken or loose.
    - Mercury pools do not make contact.
    - Friction in tube holder.
      - Adjust tube; it does not tilt far enough.
  - Returns to vertical without flash after repeated tilts.
    - Tube is defective.
    - Tube has lost its vacuum.
      - New tube.
  - Flashes and goes out.
    - Lead to positive electrode anode loose or broken.
- Tube continues to tilt after starting.
  - Relay does not open the circuit.
    - Winding short-circuited, friction or bent stud.
- Tube goes out.
  - Lamp carbons separated too far.
- Tube tilts feebly.
  - Voltage of circuit low.
  - Frequency of current not right.
  - Friction in tilting mechanism.
  - Tube is too heavy at bottom.
- Outfit is noisy.
  - Reactance coil loose on frame.
  - Reactance coil air gap not wedged tight.
  - Cover vibrates.
  - Operating room floor vibrates—set outfit on felt pads.
- Arc is noisy.
  - Carbons too hard—use softer ones.

NOTE—When proper vacuum exists the mercury gives off a sharp clicking sound when it is run from one end of the tube to the other. Absence of this sound and the presence of air bubbles show loss of vacuum.

Tube may be defective by short-circuiting between starting anode and cathode. When in this condition it is badly blackened.

resultant pound might damage them. Examine the tube for vacuum by noting the sound the mercury makes when allowed to roll gently about in the large chamber. If it makes a clear, metallic, click, the vacuum is good, but if the sound be dull and the mercury sluggish in moving, the vacuum is either partially or wholly destroyed. If the vacuum is poor, the life of the tube may be short, or it may not start at all.

To insure careful handling and safe delivery, Mercury Arc Rectifier tubes are always shipped by express in the special box as they come from the factory.

6. Place the tube in the holder by inserting the small part of the tube just above the anode arms in the upper clip, then gently lower it until it rests firmly on the lower support. Connect the tube and beaded leads according to diagram, Fig. 191.

7. Adjustment of current (number of amperes) at the arc is obtained by connecting lead marked "X" to studs 6, 5, 4, 3, 2 or 1 of the regulating reactance. Stud 1 gives the maximum and stud 6 the minimum number of amperes.

In starting up the first time it is best to start with lead "X" on stud 6 and move toward the maximum position by steps until the desired current is obtained, as indicated by ammeter. For this adjustment it is advisable to connect an ammeter in series with the arc of the projector.

8. With the above instructions carried out, all that is necessary to start is to close switch in the 'AC" line, and bring carbons of lamp together. The automatic shaking device should then rock the tube until the tube starts. As soon as tube starts separate carbons.

9. The best and whitest light can be obtained when ⅝ in. cored carbon is used above and ½ in. solid carbon below, being careful not to get solid carbons too hard.

WESTINGHOUSE MERCURY ARC RECTIFIER.—In Plate 1 we get a view of the front of the Westinghouse Mercury Arc Rectifier designed for use on projection circuits. It is built in 30, 40 and 50 ampere sizes, the general design, characteristics and appearance being the same for all.

Each outfit consists of a cast iron main frame on which is mounted an auto-transformer, L-L, Plate 3; reactance coil, Q, Plate 3; a tilting mechanism, B, D, K, P, Plate 2; a relay, I, Plate 3; a five-point dial switch, Plate 1, and E, F, G, H, I, Plate 2; adapting links, Plate 1; a tube and tube holder, 24, 25, 26, Plate 4, all inclosed in a perforated sheet steel cover. The machine occupies but little floor space.

In Plate 2, we have a view of the rectifier with the perforated sheet steel cover, the cover of the dial switch and the tube removed. At the bottom, in the corner, is the tilting magnet, P, the operation of which is very clearly shown. When magnet P is energized, its plunger, K, moves downward and tilts or rocks the tube. The construction of the dial switch is also very clearly shown, the round buttons, E, being dummies, over which switch contact fingers G slide

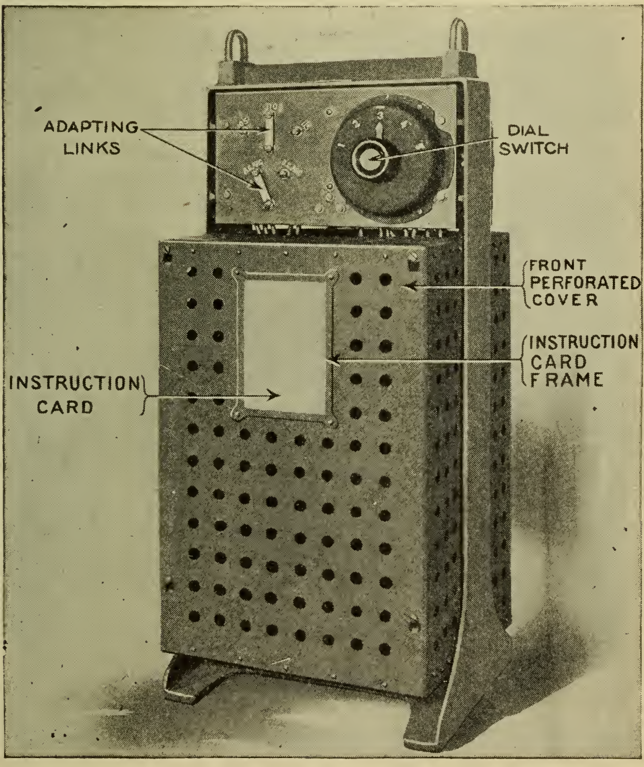


Plate 1, Figure 192.

from one wide contact, F, to another. At the bottom are four wires, L, M, N, O, coiled up and terminating in brass spring clips. These are the leads which connect to the anodes and cathodes of the tube, as per 9-9-12-29, Plate 4.

In Plate 3 we have a rear view of the outfit, showing, near the bottom, the reactance Q, and above it the auto-transformer L-L. In Plate 3 we see at the left the D. C. leads,

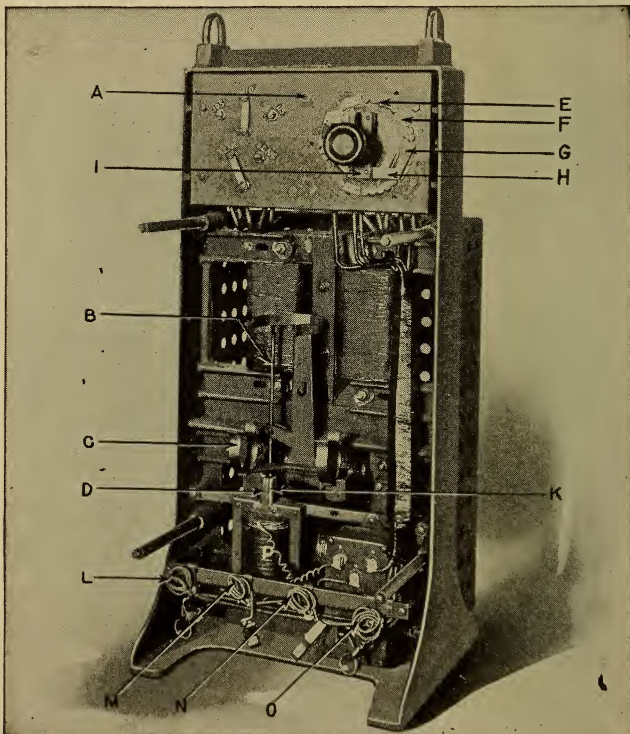


Plate 2, Figure 193.

A, mounting screws for relay; B, upper bulb spring holder; C, lower bulb spring holder; D, brass guide for tilting rod; E, dummy contacts; F, contacts; G, contact finger; H, contact arm; I, insulating support for contact; J, bulb holder casting; K, tilting magnet plunger; L, M, N, O, wires having spring contacts at end to connect to tube anodes and cathodes.

A, B, which connect to the arc lamp circuit, the inside one, A, being the negative and the outside or left hand one B, the positive. The positive must, of course, connect through the projector table switch to the top carbon arm of the lamp, and the negative through the projector table switch to the bottom carbon arm of the lamp. The A. C. leads, H, are seen in Plate 3 at right hand side. These leads connect directly, through a switch and fuse, to the alternating current supply. In the center, at the top of Plate 3, is relay magnet 1, the purpose of which will be explained further on.

THE AUTO-TRANSFORMER, L-L, Plate 3, consists of an iron core with a winding of heavy copper wire. It is similar to an ordinary transformer, except that its connections are such that in effect it has only one winding, whereas the ordinary transformer has two, viz.: a primary and secondary. Its function is to change the voltage of the A. C. supply circuit to the pressure required at the arc. The center point of the winding also forms the negative terminal of the arc circuit, as per 3, 4, 4, in diagram, Plate 5. See Fig. 199, page 546.

REACTANCE COIL.—The reactance coil, Q, Plate 3, is similar in appearance and construction to a transformer. It is connected into the alternating current circuit for the purpose of limiting current flow when the carbons are brought together to strike the arc, to a value that will not be injurious to the tube; also it operates to insure steadiness of the arc and to prevent any wide fluctuations of the current when the length of the arc is changed. The general effect is to make the arc much easier to handle.

TILTING MECHANISM.—Each rectifier is provided with an automatic tilting device, consisting of parts B, D, K and P, Plate 2. This device is so connected that the closing of the carbons energizes magnet P and thus causes the tube to tilt, which makes the rectifier a self-starter. The mechanism is operated by magnet P, Plate 2, the pull of which is applied to the tube by coil spring B, Plate 2, as shown. A spring is used instead of a rod in order to prevent the tube from being subjected to unnecessary and violent shock.

THE RELAY, 1, Plate 3, is another magnet, used to operate the contacts which open the tilting magnet circuit when the arc is started, thus preventing the tube from tilting at any other time. But for this cutout the tilting magnet would continue to operate, and the tube would be tilted, or rocked continuously.

THE FIVE POINT DIAL SWITCH, Plates 1 and 2, is used to change the connections to the reactance coil in such way as to vary the arc current to any desired value within the limits of the machine. This switch, as its name indicates,

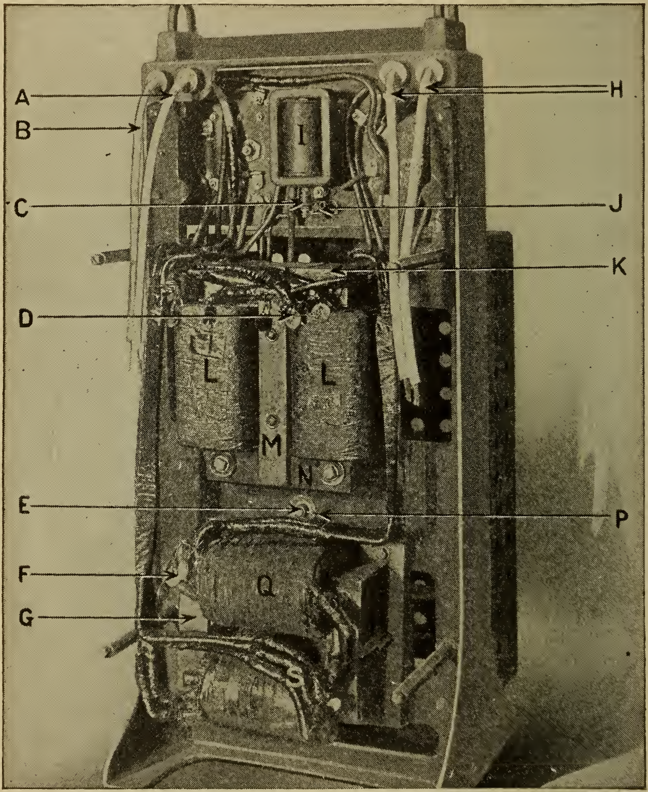


Plate 3, Figure 194.

A, positive D. C. lead; B, negative D. C. lead; C, relay contact disc; D, transformer lead tags; E, rear end of bulb holder shaft in ball bearing; F, reactance lead tags; G, fibre clamping blocks for reactance coil; H, A. C. leads; I, relay magnet; J, relay contact stud; K, transformer iron; L, transformer coil; M, clamping block for transformer iron; N, mounting bolt for transformer; P, cotter pin; Q, reactance coil; R, reactance iron; S, reactance coil leads.

gives five different values of current, and the change may be made from one point to another without breaking the arc.

THE UPPER ADAPTING LINK, 17, Plate 4, is for the purpose of changing the connections to the reactance coil, so as to provide proper voltage adjustment at the arc for different supply circuit voltages. In other words, the A. C. supply may be 220 or 110 on the face of it, whereas the actual pressure in the theatre, owing to drop in line, etc., may be anywhere between 210 and 230, or 105 and 115 volts. By means of this link it is possible to provide for these variations and make a connection suited to the actual voltage, which easily may be determined by using an A. C. voltmeter. If a voltmeter is not available the lighting company should be requested to make the test.

THE LOWER LINK CONNECTOR, 18, Plate 4, is used in emergency, to transfer the arc from the tube circuit to direct operation on the alternating current circuit, in case the tube should fail or something else happen to the rectifying side of the machine. For direct current operation (rectification) this link should be placed so as to join the lower of the three terminals and the upper right hand terminals, marked "D. C. Arc"; for alternating current operation the link should join the lower terminal and the upper left hand terminal marked "A. C. Arc." Be sure that the wing nuts are well tightened so as to clamp the links firmly.

THE TUBE is a glass vessel into which a small amount of mercury has been placed, and from which all the air has been removed, causing a vacuum. The general characteristics of its operation have been described under "General Remarks," page 515. It has four terminals, the upper ones being the graphite anodes, the smaller, lower one the starting anode and the larger lower one the cathode; both the two lower are of mercury. These various terminals are connected to coiled leads L, M, N, O, Plate 2, by means of brass spring clips, as at 9, 9, 12, 29, Plate 4.

INSTALLATION.—The rectifier will be received in two shipments. The glass tube, carefully packed in a special crate, is usually sent by express, whereas the remainder of the outfit, being the completely assembled rectifier (except the tube) all ready for operation, will probably be sent by freight. When the outfit is received, remove it from its case and place in the location selected. Remove the perforated sheet steel cover and connect the A. C. feed wires to rectifier leads H, Plate 3, through a line switch and fuses,

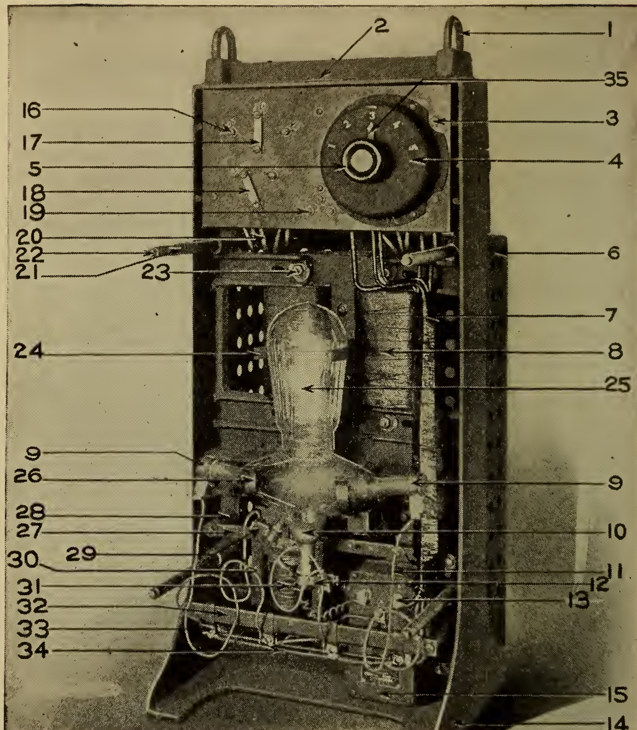


Plate 4, Figure 195.

1, lifting lug; 2, name plate; 3, mounting bolt for slate panel; 4, cast iron cover for dial switch; 5, dial switch handle; 6, rear perforated cover; 7, cable containing leads; 8, transformer; 9, spring clip on side terminal of bulb; 10, mercury pool in bulb; 11, lead to side terminal of bulb; 12, spring clip on large lower terminal of bulb; 13, resistance box terminal; 14, main cast iron frame; 15, resistance box; 16, stud for link connector; 17, upper link connector; 18, lower link connector; 19, end of relay contact stud; 20, transformer leads; 21, stud for front perforated cover; 22, bolt for front perforated cover; 23, mounting bolt for transformer; 24, upper bulb holder spring; 25, bulb; 26, lower bulb holder spring; 27, mounting strap for tilting magnet and resistance box; 28, lug for tilting magnet and resistance box; 29, spring clip on small lower terminal of bulb; 30, tilting magnet frame; 31, tilting magnet coil; 32, terminal board; 33, connector on terminal board; 34, wiring from terminal board; 35, dial switch pointer.

as per instructions mounted on front cover of the rectifier. Connect leads D — and C + to the projector table switch with the positive (+), B, Plate 3, connected to the top carbon arm and the negative (—), A, Plate 3, connected to the lower carbon arm. Open the crate containing the tube by removing two screws from the center of each side. Lift the outer portion of the crate away, which will leave the tube suspended from the inner portion of the crate. Loosen the line tape and lift the tube carefully from the holder. Turn the tube upside down, slowly and very carefully, making sure that the mercury runs slowly into the two bottom terminals. The mercury in a tube that is in good condition should make a sharp metallic click when passing from one end of the tube to the other. Grasp the tube firmly in both hands, the right at the extreme top and the left grasping the mercury terminals, and, guarding carefully against collision, slide the tube into the lower spring clips of the tube holder, taking care that the springs do not cause the tube to slide into the tube holder with a jar.

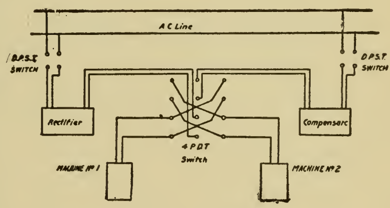


Figure 195a.

Be very careful not to allow the smaller mercury terminal to strike the tube holder, or any other object, as it is quite easily broken. After the lower part of the tube is properly placed, push the top part gently back into the upper spring. If it becomes necessary to remove the tube, as in case of changing location of outfit, the same method of handling should be followed. Connect the tube leads (that is, the flexible wires attached to the terminal board below the tube marked L, M, N, and O, Plate 2) to the tube, as shown at 9, 9, 12, 29, Plate 4. The wires may easily be traced in Plate 4. Connect wire 4, Plate 2, to the upper left hand tube terminal, 9, Plate 4; the lead M to the small lower tube terminal, 29, Plate 4; lead N to the large lower terminal, 12, Plate 4, and lead 0, the last one, to the right hand upper terminal, 9, Plate 4. The upper link connector on the slate panel at the top of the outfit should now be connected to suit the voltage of the supply wires, which should be determined by actual test with a reliable voltmeter. It may be noted in this connection that the voltage for which the link is set should be tested when the rectifier is in actual operation, since the voltage of the line may decrease with the added load. It is unlikely that once this connection is properly made it ever will be necessary to change it. The outfit, without any further adjustment, is now ready for operation.

Plate 5 shows the wiring diagram for the three types of the Westinghouse rectifier. These diagrams are, we believe, of questionable value to the average projectionist. However, there are a goodly number who will be able to make use of them. The upper one is for the 30 ampere, 110-220 volt, the center one for the 40 ampere, 110-220 volt, and the lower one for the 50 ampere, 110 volt rectifier.

OPERATION.—With fuses of proper capacity in place, close both the A. C. line switch and the projector table switch and bring the carbons together, whereupon the tube will rock, a spark appearing between the two mercury pools at each tilt until the arc starts, when the whole tube will light up and come to rest in a vertical position. The carbons should be instantly separated until the greatest amount of light is obtained on the screen.

Where the size of the theatre and equipment only justifies the purchase of a single rectifier, the problem of blending one reel into the next has been solved as described below: The only extra equipment necessary is a compensator or economy coil such is is usually found in a theatre using alternating current, and a four-pole, double throw switch.

The wiring is shown in Fig. 195a and requires no elaborate explanation. By means of this plan the change-over may be made without any very seriously objectionable indication of the fact on the screen. The projectionist, we will say, is showing the first reel of a feature film on machine No. 1, which is fed from the rectifier, the switch being thrown to the left. About one minute before the end of the reel is reached he throws the switch to the right, starting the arc on machine No. 2 through the rectifier, while projector 1 is transferred to the alternating current supply of the compensator, and the reel is completed in this manner. This gives the carbons on No. 2 time to burn to their proper brilliancy on D. C., ready to begin the second reel. The process is repeated toward the end of the second reel on projector 2. The procedure may, if desired, be reversed; that is to say, starting machine No. 2 on alternating current and later changing it to direct current. However, the first mentioned will be found more satisfactory, as it takes a short while for the direct current to burn the crater properly

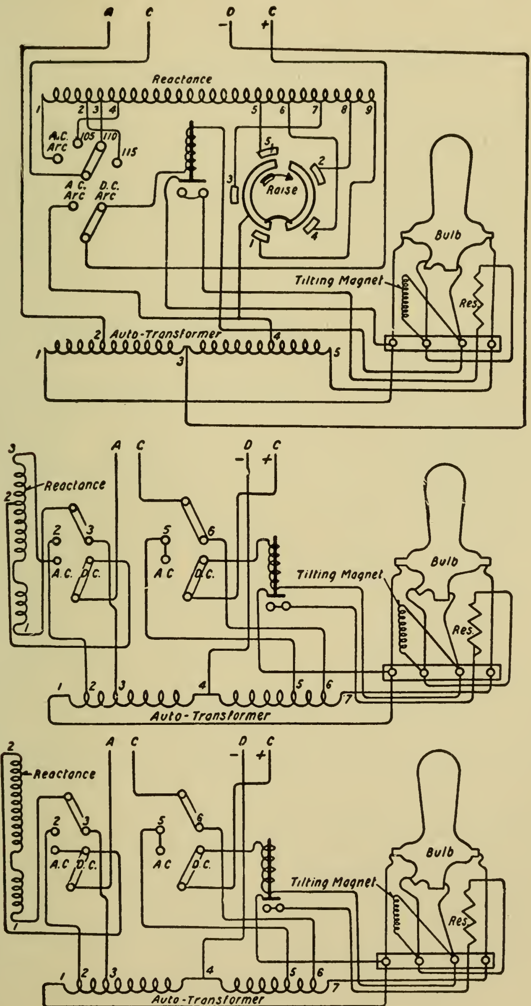


Plate 5, Figure 196.

The Transformer

THE transformer cannot be used on direct current. It is a device made entirely for use with A. C. Its purpose is to change alternating current of any given cycle (frequency) and voltage and amperage to an alternating current of the same cycle, but of different voltage and amperage.

The transformer assembly consists of four separate elements, viz.: a laminated core of iron, a primary coil, a secondary coil and a protecting casing or covering. In addition to this there may be other elements, such as an adjusting switch by means of which the amperage delivery of the secondary coil may be varied.

In Fig. 197 we have diagrammatic representation of the simplest form of transformer. The primary coil is wound around one "leg," or side of a laminated iron core, from which it is completely insulated. The secondary coil is wound around the other leg or side of the core, from which it also is completely insulated. In Fig. 197 it is only intended to convey a general idea of the relation of coils and core. In actual practice the coils are located as close together as they can be gotten. In some forms of construction one coil is inside the other.

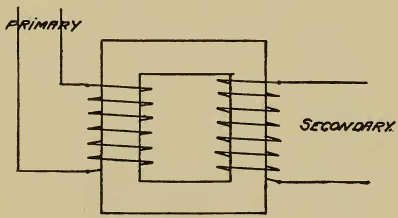


Figure 197.

ELECTRICAL ACTION.—The electrical action of a transformer is primarily based on the fact that if a wire be charged with alternating electro motive force it will be surrounded by a magnetic field, as illustrated in Fig. 198, in which A is a wire charged with A. C., B another wire having no mechanical connection with wire A, and the circles lines of magnetic force. Under the conditions shown, although wire B has no metallic connection with wire A, and is electrically insulated therefrom, an alternating current electro motive force will be induced or generated in wire B, and if wire A and B form complete circuits, current will flow in B.

A transformer depends for its action on this principle, supplemented by the following: When the switch is closed, charging the primary coil in Fig. 197 with alternating E. M. F., the wires thereof instantly become surrounded by lines of magnetic force, as shown in Fig. 198, and these lines of force acting on the iron core create a magnetic field of great intensity. This causes the primary coil to become in effect a choke coil of such power that unless current be taken from the secondary, and power be thus consumed, no wattage at all will be consumed in the primary coil. Electro motive force and current is generated in the secondary coil, which is immersed in the magnetic field created by the primary coil, because the magnetic field is in fact a magnetic circuit, its lines of magnetic force flowing in a fixed path through the air from the north pole to the south pole of the field.

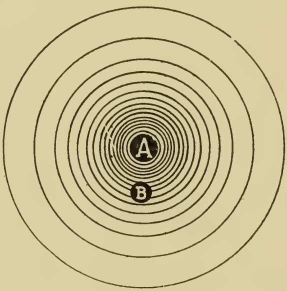


Figure 198.

Reverting back to "How Electricity Is Generated," Page 6, we find that electricity is generated in the armature of a dynamo because the wires cut across the lines of magnetic force which constitute the magnetic field. In a transformer the same identical thing is true in reverse. Current is generated in the secondary coil by reason of the fact that, instead of the wires themselves moving and cutting lines of force, the flow of magnetic energy "cuts" or passes across the wires, which amounts to exactly the same thing as the wires cutting through or across the lines of magnetic force, hence a current of electricity, called the secondary current, is generated or "induced" in the secondary coil. This secondary current is termed an "induced" current.

The action of a transformer is entirely automatic. The primary current creates a magnetic field which, as already explained, generates or "induces" a current in the secondary coil. This latter current also sets up a magnetic field, but its magnetic flow is in a direction opposite to the flow of the primary field. It therefore follows that when the secondary current flow is increased or decreased, the relative strength of the two magnetic fields (primary and secondary) is altered, whereupon the amount of current the primary coil takes from the lines is automatically increased or decreased until just sufficient is taken to maintain the balance between the magnetic fields. The action of a transformer, therefore, depends upon the balanced magnetizing action of its two coils.

Roughly the foregoing describes the electro-magnetic action of all transformers.

TWO TYPES.—There are two types of transformer, viz.: the straight transformer, in which there is no mechanical connection between the two coils, and the auto transformer, the wiring of which is illustrated in Fig. 199. The auto

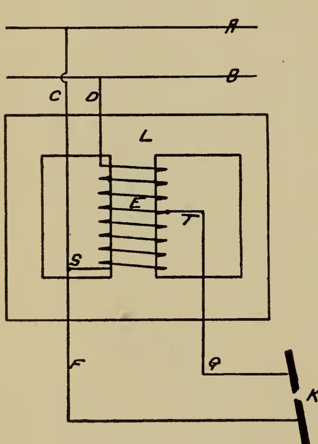


Figure 199.

Figure 200.

transformer is an instrument having but one coil or winding, which serves for both the primary and the secondary coil, In Fig. 199, L is a laminated iron core on which the primary and secondary are wound in the form of one coil, or if you prefer it, two coils connected in series so that they practically form one coil. The primary wires are connected as shown, one to the terminal of the primary coil and the other to the terminal of the secondary coil at S. The secondary wires connect to one terminal of the secondary coil at T, and to the other terminal of the secondary coil at

S, as shown. The ratio of secondary voltage to primary voltage will depend upon the ratio of the number of turns in the primary as compared to the number of turns in the secondary, just as in the ordinary transformer.

If connection T were made in such way that the number of turns in the primary would be two-thirds the total number of coils in the primary and secondary combined, then the secondary voltage would be about one-third the primary voltage, and the secondary amperage will be about three times that taken from the supply lines. The auto transformer may be, and frequently is, so made that the secondary terminals may be, by means of proper switches, connected to points located anywhere along the length of practically the entire winding. There is at least one auto transformer which is designed for projection work. It is the product of a western coast manufacturer. It is reported as giving satisfaction. .

EFFICIENCY.—Assuming a 100 per cent. efficiency, the watts consumed in the primary coil will equal the wattage output of the secondary coil. Like all other devices, however, the transformer is not 100 per cent. efficient, though if well designed it should have an efficiency of better than 90 per cent. The losses in the transformer consist in what is known as core and copper losses, the percentage of loss depending upon the construction of the device. **If a transformer which is in good order operates at high temperature, it is evidence of lack of efficiency, as core and copper losses appear in the form of heat.**

TRANSFORMER CORE.—The core of a transformer consists of thin sheets of sheet-steel, technically known as "electrical steel." The sheets are painted on either side with an insulating compound and then clamped together into a solid mass. The thickness of the sheets of metal necessary for best performance is dependent on the cycle of the current the device is to operate on.

RATIO OF TRANSFORMATION.—A transformer may either be a "step up" or a "step down" transformer. A step down transformer is one in which the secondary voltage is lower than the voltage impressed upon the primary, and the amperage correspondingly greater. For instance, if a transformer were 100 per cent. efficient and ten amperes at 100 volts ($10 \times 100 = 1{,}000$ watts) were taken from the supply lines, and in the process of transformation the voltage was lowered to 50, then the secondary amperage would be 20, because 1,000 watts ÷ 50 volts = 20 amperes, and with 100 per cent. efficiency the primary wattage divided by the secondary voltage must and would be equal to the secondary amperage. This always holds true, subject only to modification by the losses inherent in the transformer itself.

A step up transformer is one in which the voltage induced in the secondary is higher than the voltage impressed upon the primary, and the amperage correspondingly lower, thus reversing the action of the step down transformer. As in the case of the step down transformer, however, the wattage of the secondary will be equal to the wattage of the primary, less the losses inherent in the device itself.

The ratio of transformation depends upon the relative number of turns of wire in the primary and in the secondary. If the number of turns in the primary exceed the number of turns in the secondary, or in other words if there are a greater number of turns of wire in the primary than in the secondary coil, the action will be that of a step down transformer. In the case of a projection transformer, the voltage of the secondary must be just sufficient to force the desired number of amperes against the resistance of the secondary circuit and the arc.

This is easily calculated. For example: A transformer with 100 turns in its primary and 10 turns in its secondary coil, will have a transformation ratio of 10 to 1, and if the primary voltage be 100, the secondary voltage, at no load, will be 10. If 10 amperes flow in the primary of a transformer having a transformation ratio of 10, then 10 x 10 amperes will flow in the secondary. The whole matter is summarized in the following:

Primary voltage: Secondary voltage = primary turns: secondary turns.

Primary amperes: Secondary amperes = secondary turns: primary turns, from which it is evident that, except for losses in the device, the wattage of primary and secondary will always be equal.

In examining the step-down transformer it will be found that the wires of the secondary coil are larger than the wire of the primary coil. This is because of the fact that the secondary amperage will be higher than the primary amperage, hence a wire of larger capacity is required.

The coils are completely insulated electrically from each other and form the core, but magnetic lines of force pass through insulation just as though it were not there.

RELATIVE POSITION OF THE TWO COILS.—While Fig. 197 shows the theoretical construction of the transformer, in actual practice the two coils are either wound one over the other, or they are placed side by side. In any event they are as close together as they can possibly be gotten, in order that the secondary coil be located in the strongest part of the magnetic field set up by the action of the primary coil and the core.

Broadly, this describes the general plan of construction and action of the transformer. Those who wish to delve more deeply into the matter of transformer construction and action may do so by consulting Hawkins' Electrical Guide No. 6, pages 1377 to 1456, wherein will be found a very complete, well illustrated description of the construction, the theoretical and the practical action of the transformer.

LOW VOLTAGE TRANSFORMERS.—For use on projection circuits, where the supply is alternating and it is for any reason not deemed expedient to rectify the current by means of a motor generator or mercury arc rectifier, there are a number of devices which are in fact nothing more or less than low voltage transformers. These transformers are made especially for use on projection circuits. They pass under various trade names. The three best known and most largely used are the "Economizer," which was the invention of J. H. Hallberg; the "Inductor," which is the product of the Nicholas Power Company, and the A. C. to A. C. "Compensarc," which is made by the Fort Wayne branch of the General Electric Company. They are all of the type known as "constant current transformers."

These devices take A. C. directly from the supply lines and deliver A. C. secondary current at arc voltage. They are all so constructed that the amperage of the secondary may be altered, usually in three steps, merely by the manipulation of a suitable switch connected to taps from the primary winding, (see Fig. 200), modified by the fact that in the older types of one of them, the economizer, the change in secondary amperage is accomplished by means of changing the primary connections, either directly or by means of changing the position of a plug fuse, instead of by means of a switch. They are, of course, all of them step down transformers. The maximum capacity of these transformers is 60 amperes, but most if not all manufacturers make a special high capacity instrument.

We would suggest to manufacturers of this type of transformer that instead of the regular stock transformer having a range from 40 or 50 to 60 or 65 amperes, as is the present practice, the purpose would be very much better served if such devices had a range of from 50 to 80, because 50 is as low an alternating current amperage as ought to be used for the projection of modern motion pictures, and 80 amperes is none too high for good work.

ADJUSTMENT.—The change of secondary amperage usually is accomplished by means of "tapping in" on the primary coil. This is illustrated in Fig. 200, in which A-B-C are wires connecting with the primary coil at various points, and D the adjusting switch of the transformer. Remembering that the E. M. F. and the amperage of the secondary is dependent upon the relative number of turns of wire in the primary and scondary, it will readily be understood that the altering of the position of switch D would alter the voltage and amperage of the secondary, since it would add to or reduce the active turns of wire in the primary coil. We believe no further explanation of this point is necessary, since the drawings and what has already been said, should make the matter sufficiently clear. Change in secondary amperage may also be accomplished by altering the position of the primary and secondary coils with relation to each other.

WIRE SIZES.—Where the projection circuit is served by an Inductor, Economizer, or Compensarc of 60 amperes secondary capacity, the usual custom is to install primary circuit wires of only sufficient capacity to carry the primary current, which will be decidedly less than the secondary current. We would, however, recommend that the primary and secondary circuit wires be of equal size, with a capacity of, say, 70 amperes, because in case something goes wrong with the low voltage transformer it may become necessary to temporarily install a rheostat, and if this be done, certainly one would not wish to pull less than 60 amperes, under which condition the wires of the primary circuit would be too small.

PERMISSIBLE TEMPERATURE.—See Page 511.

THE CHOKE COIL.—The choke coil, also called a "reactance" coil, is diagrammatically illustrated in Fig. 201. It represents what might be called magnetic resistance. If an iron core consisting, in practice, of thin sheets of metal, be built up, and one of the insulated wires of an alternating circuit be wrapped a number of times around it, as shown, magnetic reactance will be set up, which will have the effect of offering resistance to current flow. This is also called "magnetic kick." The magnetic field set up around the core of the coil has the effect of creating a counter E. M. F., which opposes the line voltage and reduces it. The practical effect upon current flow is essentially the same as that of the rheostat, but the choke coil is very much more economical in operation than is the rheostat, though it is not nearly so satisfactory for the production of projection light as is the transformer or auto transformer, or even the rheostat, largely by reason of the fact that it has a tendency to produce flaming at the carbons; also projection light from an arc supplied by a choke coil usually has a harsh, bluish, very unpleasing tone.

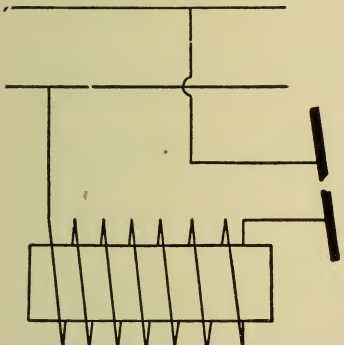


Figure 201.

TWO WIRE TO THREE WIRE.—Transformers may be built to take current from a two wire supply and deliver to a three-wire system, as per Fig. 202.

MULTIPLE CONNECTION. — Projection transformers of the same voltage and cycle rating may be connected in multiple in order to increase the amperage at the arc. To accom-

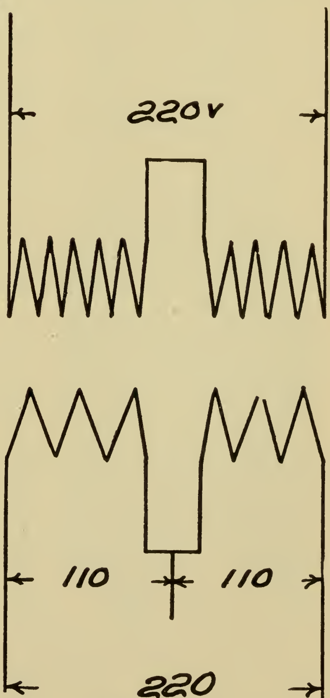
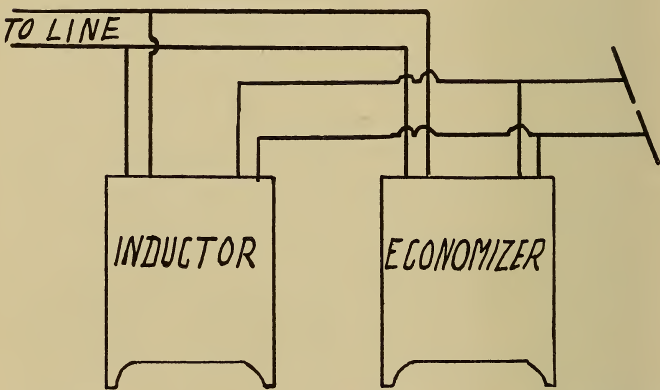


Figure 202.

plish this, connect the two economizers, compensarcs or inductors (an economizer and a compensarc, a compensarc and inductor or an inductor and economizer may be thus connected) to the supply separately, just as though each was to work alone, then connect the secondaries as shown in Fig. 203.

Having made this connection, it is permissible to set one transformer at its maximum and the other at its minimum capacity. By this arrangement a very wide range of current flow is available.

GENERAL ELECTRIC A. C. TO A. C. COMPENSARC.—This device is made by the Ft. Wayne branch of the General



MULTIPLE CONNECTION. SWITCHES AND FUSES OMITTED.

Figure 203.

Electric Company. Its general appearance is shown in Fig. 204. It is entirely self-contained, is well built and delivers 40, 50 and 60 amperes to the arc.

CAUTION: Before installing see that the voltage rating and cycles on the name plate correspond with that of the current supply.

LOCATION AND CONNECTIONS.—The compensarc should be so located that its controlling switch will be within easy reach of the projectionist from working position beside the projector. Any other location will greatly lessen the value of amperage control.

The connections are shown in Fig. 205. The "line" and "lamp" terminals are plainly marked on the top of the device, so that no mistake is possible in connecting. Connect the taps marked "line" to the supply line, through fuses and switch, and the taps marked "lamp" to the projector table switch. It makes no difference which wire leads to upper or lower carbon.

The compensarc employs the means of changing secondary amperage illustrated in Fig. 206, in which A-B are small reactance coils which are cut in or out of series with the primary coil by means of switch lever, which swings to the left, its outer end carrying the handle seen on the top Fig. 206. Tracing the current, Fig. 206, you will see it must pass through both coils A and B, but with the switch making contact with E, coil B is eliminated, and with the switch in contact with F both coils A and B are cut out,

The claim is that by this plan a constant current is secured at varying arc voltages.

To determine whether or not all the switch contacts are in good condition, start the arc on low and then watch the effect on the screen illumination as you move the switch to intermediate and high. If the device is in good order on all steps the effect will be quite visible.

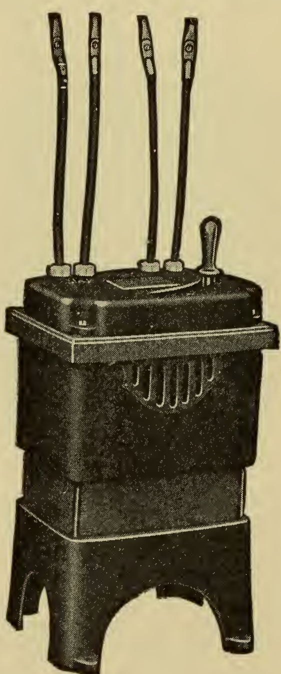


Figure 204.

POWERS INDUCTOR

The Powers Inductor, Fig. 204a, consists of a well insulated, strongly clamped laminated core with the primary wound on one side or leg of the core and the secondary on the other. The casing consists of a cast-iron front and back, with a perforated fibre cover. On the front, at the top, two wires emerge, underneath which, on the casting, is the word "lamp." These two wires connect directly to the carbon arms of the projector lamp. It makes no difference which wire you connect to the upper or lower carbon arm. At the rear side, near the top, the two primary leads come out. They should be connected to the supply, as per Fig. 205, Page 607. On the face of the front casting is a handle which operates a single-pole knife switch, located on the opposite side of the casting. When this switch is thrown so that its finger points toward "high" you are getting the maximum amperage, approximately 65 if the supply voltage is 110. When it points to "medium" you are getting a medium amperage, and when it points to "low" you are getting lowest amperage transformer will supply.

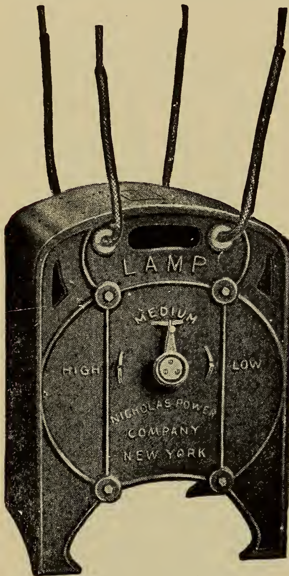


Figure 204a

The inductor is designed for a maximum of 65 amperes on "high," 54 on "medium," and 45 on "low" when used on 110 or 220 volts, it being, of course, understood that you cannot use 110 volt inductor on 220, or a 220 on 110. In other words, you must have an inductor suitable to the voltage of your supply; also it must be suitable to the cycle of the current you use, though the inductor may be used on voltage ranging 10 per cent. below to 10 per cent. above that for which it is rated, but in one case there will be a corresponding increase, and in the other a decrease in its rated amperage. The inductor is designed for a maximum temperature rise of 50 degrees Fahrenheit above the surrounding atmosphere, and ordinarily its temperature will not exceed 30 degrees in excess of the surrounding air. It occupies 12 x 14 inches floor space, is 19 inches high, and weighs approximately 100 lbs. Its efficiency rating will compare favorably with others.

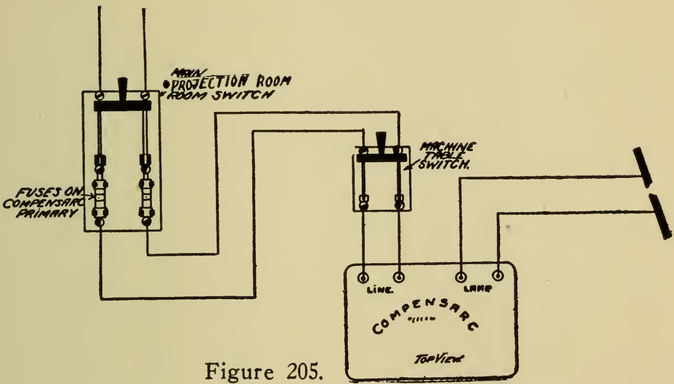


Figure 205.

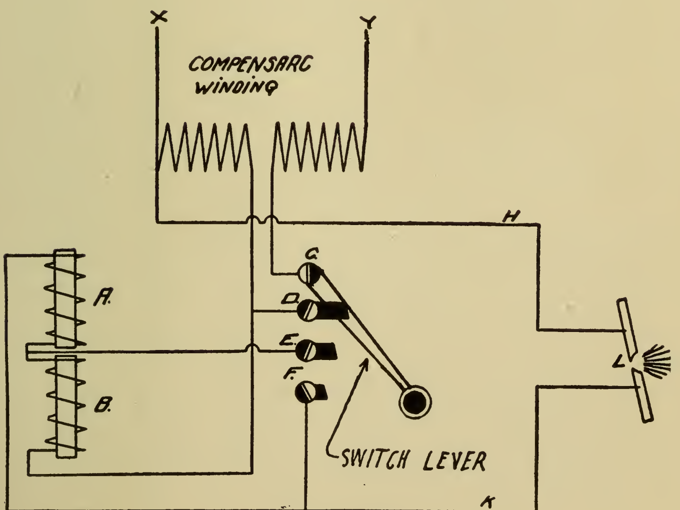


Figure 206.

A-C. COMPENSARCS

Approved by the National Board of Fire Underwriters

60, 50, 40 AND 25 CYCLES
110 and 220 Volts

KW.	VOLTS	60 CYCLES		50 CYCLES		40 CYCLES		25 CYCLES		NET WT. in Lb. (Apprx.)	DIMENSIONS IN INCHES (Approx.)		
		CAT. NO.	SHIP. WT. in Lb. (Ap-prox.)	CAT. NO.	SHIP. WT. in Lb. (Ap prox.)	CAT. NO.	SHIP. WT. in Lb. (Ap-prox.)	CAT. NO.	SHIP. WT. in Lb. (Ap-prox.)		Height	Width	Length
2	110	223736	160	223922	170	223920	170	223918	180	135	22¼	10	12
2½	220	223737	180	223923	190	223921	190	223919	200	155	23¼	10	12

NOTE.—Compensarcs can be built for any three specified ratings of current at 35 volts at the arc. Standard rating of 40-50-60 amp., 35 volts, will be furnished wherever it is possible.

Arc Controllers

THERE no longer exists any legitimate excuse or reason for using a hand fed projection arc, no matter whether it be a high intensity, a reflector type or an ordinary arc. There are several excellent arc controllers now available, and the improved results brought about by their use as against the hand-fed arc far more than justifies their cost.

Electric-magnetic arc controllers have as their motive power a small direct current motor, which feeds the carbons, both positive and negative, forward intermittently as they are burned away, and at a rate which maintains what is, to all intents and purposes, a constant length of arc gap.

As has been said, the carbons are fed forward to the arc intermittently, and not continuously. This action is accomplished by means of a solenoid, or solenoids (some types of controller use one and some two solenoids, but where two are used they are so connected that they act as a unit in the control of the motor circuit) so connected that when the arc voltage rises the solenoid pulls its armature toward itself, against the action of a small spring which holds it, the armature, normally away from the solenoid contact.

This action of the armature of the solenoid has the effect of opening the circuit of the motor which drives the arc controller mechanism, thus stopping the motor and halting the feeding of the carbons forward to the arc.

When the feeding of the carbons has been thus stopped, it is not resumed until the arc has lengthened sufficiently to raise its voltage enough to increase the pull of the solenoid until it again overcomes the pull of the spring, and draws the armature toward it, thus closing the motor circuit.

Reduced to simple terms this means that, in practice, every change in distance between the carbon tips of an arc alters the arc voltage, because it operates to change the resistance of the arc. As the distance between the carbon points increases the arc voltage rises, since a higher voltage is necessary to force the current across the wider opening. Conversely, as the distance between the carbon tips is decreased the arc voltage is reduced.

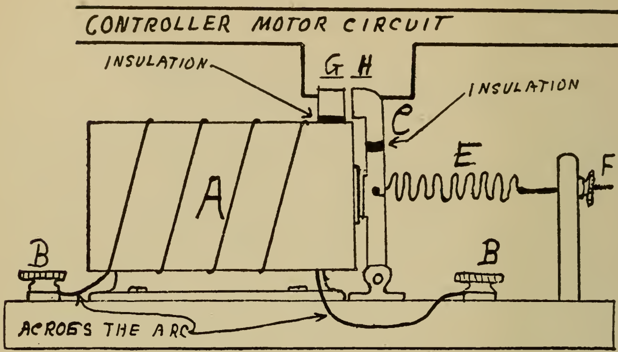


Figure 208.

In Figure 208 we have intended merely to illustrate what has been already set forth, without regard to constructional details. A is a solenoid, connected "across the arc, through binding posts B B. It is wound with fine, insulated wire. C is a small bar of iron, called an "armature." It is hinged at its lower end. At its upper end are the make-and-break contacts of the motor circuit—one wire of the circuit only, of course. E is the tension spring, controlled by thumbscrew F.

As you will readily understand, when the pull of solenoid A becomes strong enough, by reason of rising arc voltage, to cause the pull of spring E to be overcome, armature C will be moved over against contact G, which will bring contact points G-H together, thus closing the motor circuit. When the carbons are fed together sufficiently to lower the arc voltage to a point where spring E overcomes the pull of the solenoid, armature C is pulled back, and thus contacts G and H are broken and the controller motor stopped.

That is the operating principle, though of course, as we have said, the actual construction of such a device is very different from that shown, the idea being merely to show you, in simple, easily understood form, the principle upon which such devices operate.

Note: For another type of controller see Strong lamp equipment, page 878.

WHY CONTROLLERS SHOULD BE USED.—A further definite statement of why arc controllers should be used is perhaps in order. In the first place, if a hand-fed arc be used, in order to secure maximum results in evenness of screen illumination, and maximum returns in screen illumination per k. w. of energy expended, it is absolutely essential that the projectionist remain constantly beside the projector, feeding the carbons a very little at a time, and very frequently—in fact, every few seconds. In no other possible way can a perfect centering of the spot at the aperture be maintained. As a matter of fact not one projectionist in a hundred fulfills this condition. This is sometimes due to the fact that the multiplicity of duties imposed upon him by the theatre management will not admit of his doing it. In other cases he does not do it because he is just too careless or too lazy,

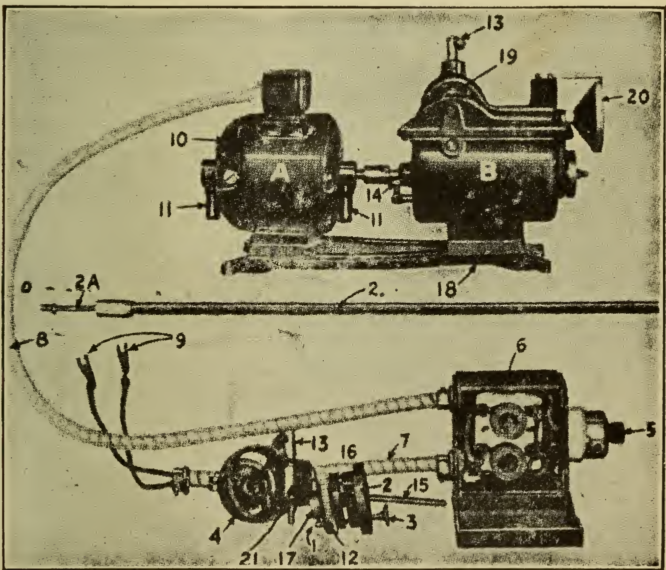


Plate I, Figure 211.

but no matter what the reason may be for such failure, the result is bad, and **justification of the investment necessary for proper arc control is more than ample.**

In considering matters of this kind, the theatre management will do well to remember that after it has invested anywhere from a few thousand to a half million dollars in a theatre building, and has paid large sums for its furnishing in the finest possible way, its ventilation in the most complete possible manner and its artistic lighting and has paid large sums for film service rental, it cannot possibly be good business to attempt to save a comparatively small sum of money by the investment of which the very heart of everything, the projection light source, will not only operate more economically and efficiently, but also will give a more even, constantly brilliant screen illumination.

We strongly advise all exhibitors using an arc light source for projection to install arc controls.

FULCO SPEEDCO AUTOMATIC ARC CONTROL is the re-designed and improved arc control formerly known as the Speedco.

The Fulco Speedco Automatic Arc Control is of the automatic type. It makes use of two basic principles, viz: Mechanical and electrical. The device is mechanically well made, and the experience of years has proven that it may be depended upon to perform the duty for which it is designed.

By referring to Plate I, you will see that the control consists of a small motor, A, directly connected through a flexible coupling to the controller mechanism, B. Controller B is connected to the arc lamp through the mechanism and rods illustrated in Plate II. The general assembly of the whole is shown in Plate V.

The controller is illustrated, in detail, in Plate I, in which 6 is the fuse box, 5 the snap switch which operates motor A, 8 the conduit protecting circuit connecting motor A and fuse box 6, 7 the conduit protecting circuit connecting the fuse box to the projector table switch, as shown in Plate IV. Beside the fuse box, to the left in Plate I, is the disassembled assembly illustrated in Plate II, in which 2 is the hand carbon feed wheel, 3 the thumb screw which locks the hand control to the mechanical control, 12 the gear operating the lamp carbon feed rod which is driven by gear 6, Plate II. Rod 2 and 2A in Plates I and II are the same, they being the rod which connects the control to the lamp carbon feed handle. This rod is adjustable in length, because rod 2A, which is square in form, telescopes into a square opening in rod 2.

Plate III illustrates the mechanism contained in controller B, Plate I. In Plate III gear 10 in the left hand illustration is the one which meshes with gear 44 in the right hand illustration (the right hand illustration being the under side of the cover of controller B, Plate I) which latter, through bevel gear 50, drives rods 2 and 2A, Plates I and II.

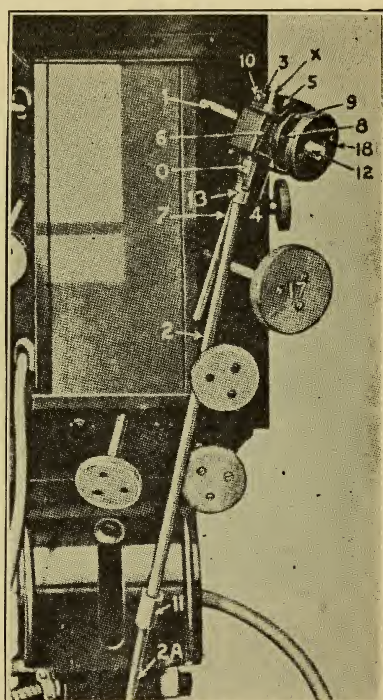


Plate II, Figure 212.

Now follow closely: Spring 41, Plate III, is attached to part 23 by slipping the bend in the end of spring 41 into eye hole 22 of part 23. When cover 40 is in place and tension is supplied to spring 41 by means of adjusting dial 20, Plate I, which operates on threaded bolt 45, Plate III, it has the effect of holding part 23, Plate III, back in the direction of arrow point 34, Plate III.

Part 28-28 are governor weights attached to governor yoke 27 by means of hinge pins 35 and 47, and right here is what might be termed the heart of the whole machine. Part 33 swivels on part 32, and the whole governor is rigidly attached to the main driving shaft by pin 38 in part 27. Part 31 is a steel tooth attached to part 23, and protruding ⅛ on an inch on the side next to wheel 16. The parts between 27½, which is a ball-bearing, and part 26, which is another ball-bearing, comprise the entire governor assembly, which revolves at the speed of the motor armature shaft, with which the controller driving shaft is directly connected, as shown in Plate I. Weights 28-28 are normally held in, in the position shown in Plate III, by means of spiral spring 41, which holds part 23 back against ball-bearing 26, whcih in turn presses back part 32, carrying pins 25 which bear on the inner end of arms carrying weights 28-28. Before proceeding any further, study this action closely and get the action clearly fixed in your mind.

And now here is how the mechanism operates. The motor runs constantly, but at a speed varying with the arc voltage.

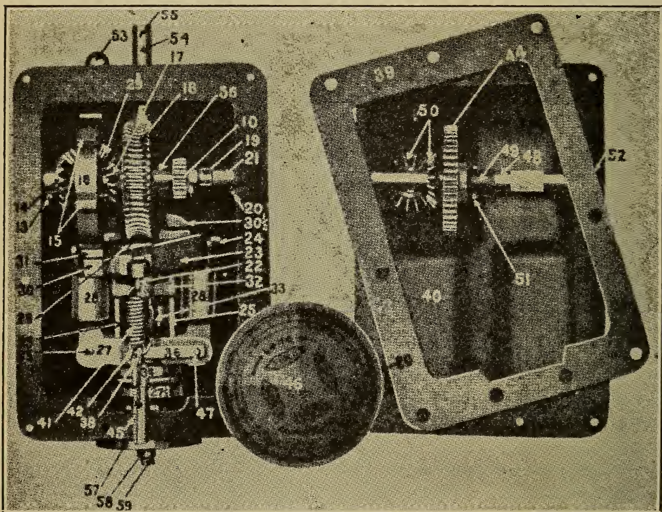


Plate III, Figure 213.

Its speed increases as the voltage is increased by the increasing length of the arc. As a result of the increased motor speed the tendency of weight 28-28 to be carried out by centrifugal force, against the pull of spring 41, has the effect of overcoming the pull of the spring and forcing part 32, ball-bearing 26, and part 23 ahead, which causes tooth 31 to engage with one of the stop teeth, 15, Plate I, on wheel 16.

Gears 14, 17 and 29 form what is known as a "differential." Gear 29 is attached to wheel 16, gear 14 to shaft 19 by means of pin 13, and gear 17 to gear 18. Underneath gear 18 is a worm gear attached to the shaft connecting the controller to the motor; in other words, to the main driving shaft. This worm drives worm gear 18, which is mounted upon, but is not attached to shaft 19; in other words, shaft 19 merely serves as a spindle upon which gear 18 revolves. When the motor is running, but with insufficient speed to cause the governor to operate, or in other words when the motor is running and the arc not being fed, gear 18 and wheel 16 are driven continuously. Wheel 16, which is also loose on shaft 19, being free to turn, gear 29 simply runs around on gear 14, but without revolving gear 14 which is pinned to shaft 19, as is also gear 10 which operates gear 44, the latter in the right-hand illustration. When the governor operates, however, it forces out tooth 31, which engages with one of the teeth on wheel 16, thus preventing the wheel from revolving, whereupon, (remember that gear 18 and wheel 16 are loose on shaft 19) since gears 18 and 17 revolve continuously, and since gear 29 locks gears 14 and 17 together when wheel 16 is not revolving, shaft 19 is rotated, together with gear 10 and gears 44 and 50, and thus the carbon feeding mechanism is operated, and the carbons fed together until the arc voltage is sufficiently reduced to slow the motor down until spring 41 pulls governor weights back again, thus releasing wheel 16 and unlocking the differential, whereupon the carbon feeding mechanism stops.

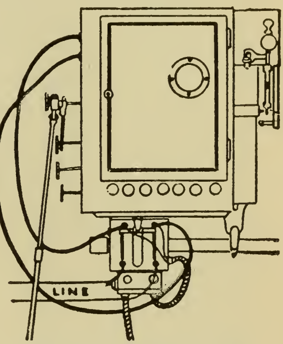


Plate IV, Figure 214.

All that sounds very complicated, but it really is not. On the contrary it is very simple once you get the idea of the action of the differential.

All gearing is fully inclosed, therefore protected from the grinding action of dust mixed with lubricant.

ADJUSTMENT.—The longer the arc the higher its voltage, therefore the faster will the motor of the controller run, and the speed necessary to cause tooth 31, Plate III, to engage with the teeth on wheel 16, Plate I, will depend upon the tension given spring 41, Plate I, by adjusting dial on wheel 20, Plate I, to maintain any desired arc length.

SUPPORTING STANDS.—Plate V illustrates different types of supporting stands. At the left the controller is seen on the floor, in the center raised about six inches, and at the right it is raised up about two feet, though the last stand can be made up, on special order, to any height required, as the supporting column can be made longer. This brings the control to any desired height, and so accommodates those extreme conditions which are at times met.

Either type of stand may be had with the outfit at a small added cost, remembering that the rod which connects the controller with the carbon feed handle is adjustable as to length, therefore, the use of the lower stand is optional, but the last or higher stand requires a telescoping rod of about half the length of those ordinarily supplied.

We advise the last or higher stand, as this raises the device out of the dirt, and looks neater; also it affords a better operating position, as it is not necessary to stoop over when making an adjustment. The stands are constructed so as to catch and hold any oil which may leak from the controller, thus keeping the floor clean and free from oil.

CONNECTING THE CONTROLLER.—When the controller is unpacked, examine the packing material very carefully to make sure it contains no small parts. The shipment will consist of the following: the controller, motor and base connected in one unit, with the necessary switch, fuse box, fuses and wire circuits protected by a flexible conduit, steel rod and tube, universal joint, fibre knobs and gearing necessary to attach the gear to the carbon feed rod of the arc lamp.

After unpacking and inspecting the parts, proceed as follows: First, set the controller and motor A and B, Plate I, on the floor immediately beneath the carbon feed handle of the arc lamp, though if necessary the controller may be set a little to one side, or a little back of the carbon feed handle of the arc lamp. This may be necessary in some cases where lamp controller handles interfere with the rods 2 and 2A, Plate I, or where the conduits coming up out of the floor prevent locating the controller in exactly the desired spot. It is, however, desirable that rods 2 and 2A, be as nearly perpendicular as possible, because universal joints 13, Plate II, will not work properly if rods 2 and 2A are set at too great an angle. This idea is illustrated in Plate V.

Switch box and switch, 5 and 6, Plate I, should be attached to the projector table switch casing, either on its under side, or to the side of the casing. This may be done by drilling suitable holes and fastening box 6, Plate I, to the projector table switch casing, somewhat after the fashion shown in Plate IV, by means of suitable bolts, after which a 13/16 of an inch hole must be drilled in the projector table switch box cover to receive the BX of circuit 7, Plate I. The only electrical connection necessary is to attach terminals 9 of circuit 7, Plate I, to the terminals of the projector table switch at the end of the switch which will be dead when the switch is open. If you attach it to the other end of the switch, the motor of the arc control will be subject to high

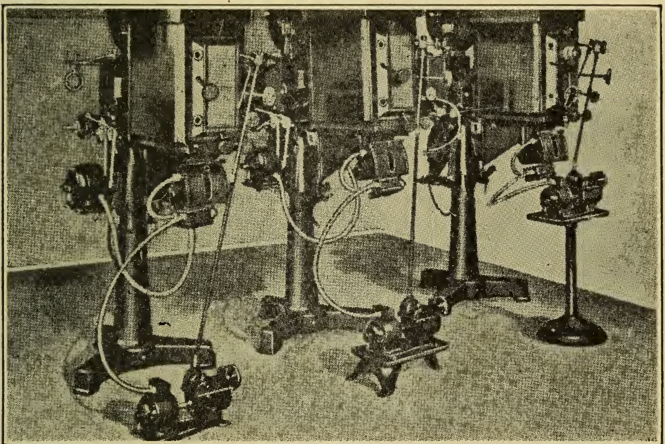


Plate V, Figure 215.

voltage, high enough to cause the carbon feeding mechanism to operate, unless switch 5, Plate I, be open. See "Caution," page 569

Do not attach the controller anywhere else except to the binding posts of the projector table switch which will be "dead" when the switch is open.

LUBRICATION.—The well formed by gear casing B, Plate I, shown with cover removed in Plate III, should be kept filled to the top of oil gauge 14, Plate I, using a good grade of dynamo oil. The oil is put in by removing thumb screw 19, Plate I, and the filling is continued until the oil reaches the top of oil gauge 14, Plate I. One filling of good lubricant should last about 500 hours, or in a house running 10 hours a day for about two months.

About twice a year the oil well should be drained. After draining fill the oil well with kerosene and let the controller run for a short time, after which drain the kerosene out and re-fill the well with fresh oil.

CAUTION.—You are cautioned against using Three-in-One, and other very thin much advertised oils, as they are totally unfit for the lubrication of a device of this kind.

The manufacturers recommend any good grade of dynamo oil, which can be obtained from your supply dealer, or from any reliable oil dealer. The oil sold by projector manufacturers for use on their projectors will serve very well.

OPERATION.—The controller will maintain the length of arc for which it is adjusted, and the length of arc it will maintain may be altered by turning adjustment dial 20, Plate I, in the direction as indicated to maintain a longer or shorter arc.

The voltage of your supply lines may change during the day, and repeat these changes day after day. Arc controller adjusting dial has its face laid off in numbered divisions, and there is a pointer, so that by making a note, or by taking a record of its operation as the dial is set at different figures, the controller can be re-set at those times when the current changes take place, without the necessity of making the daily experiment of adjusting a thumb screw or nut so as to maintain the desired arc condition. If the projection room is equipped with a reliable voltmeter it only requires a little observation to know exactly where to shift the speed controller dial to obtain the desired results from any given voltage.

CARE.—Examine the oil cups of the motor once a week and keep them filled with oil; also examine the commutator of the motor occasionally. In this connection see general instruction No. 7, Page 502, on care of the commutator. Should everything go wrong with the interior gearing of the control (very unlikely, though all things are possible) it will be necessary to return the entire mechanism to the factory for adjustment. It is not advisable that the projectionist himself attempt to repair the control mechanism. The explanation of the mechanism is not given with the idea of enabling him to repair it, but because we believe any man can work more intelligently with a thing if he under-stands its operating principle; also because the average man very naturally does not like to operate something he knows nothing about. We, therefore, provide him a better means of getting the knowledge he desires than by tearing the machine to pieces.

CAUTION.—The controller must under no circumstances be connected to alternating current, or to any voltage higher than 115. Always place snap switch 5, Plate 1, in the "open" position after extinguishing the arc.

When it is desired to resume operation, first strike the arc by hand and set it to approximately proper length, after which turn snap switch 5, Plate I, in the "on" position. This latter is important, because if the projector table switch be closed when the arc is not in operation, as is not infrequently the case, the controller motor would be subject to voltage sufficient to place the carbon feeding mechanism in operation; also, if current be taken from 110 volt direct current lines through a rheostat, the motor would be operating at line voltage, because with such a very small current flow, the rheostat would not operate.

PEERLESS AUTOMATIC ARC CONTROL.—The Peerless Arc Control is of the automatic type, and is by far the simplest, both in mechanical and electrical construction, we have yet seen.

It consists essentially of a small motor, Q, Fig. 217, which drives gear T by means of worm gear S, the latter attached to the armature shaft. Gear T is attached to and drives upright rod B, into which square rod G telescopes. This latter is to accommodate varying heights, or in other words, to cause the length of combined rods B and G to be adjustable. Rod G, through another pair of worm gears, drives carbon feed rod P.

When the carbons are not being fed, motor Q and the mechanism stands still. The running of motor Q, and therefore the feeding of the carbons, is actuated by means of a circuit passing from the motor to snap switch K, through the box to which conduit O is attached. The circuit contained in conduit O passes down through the apparatus contained in the box and on through underneath the supporting stand to the motor.

The control may be used on any make of projector. It is designed to stand on the floor, as nearly as possible immediately under the arc lamp carbon feed handle, the complete assembly being illustrated in the diagram shown in Fig. 217, in which square rod G telescopes into a square opening in rod B, which makes the length of the combined rods adjustable to suit varying heights of the carbon feed rod from the floor.

The actuating element is completely inclosed and is sealed

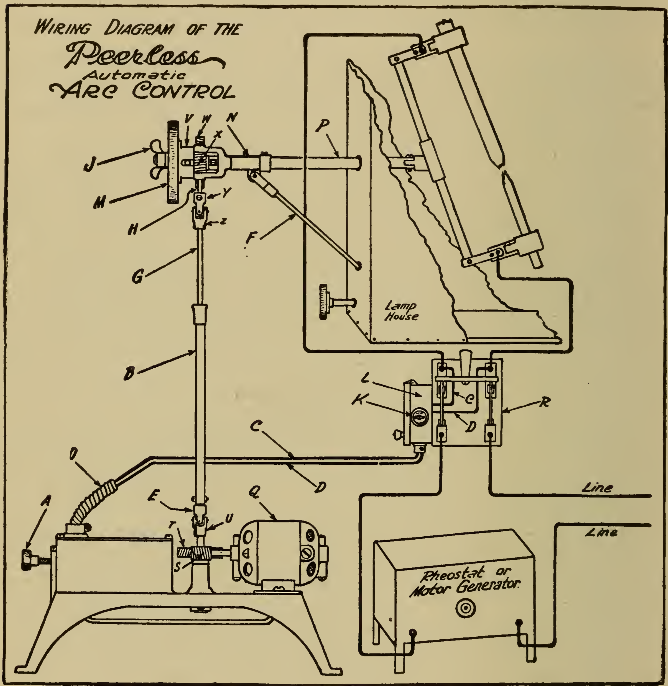


Figure 217.

When the machine is received you will find attached to one of the seals a printed warning that if the seal is broken the guarantee on the machine is voided.

For the benefit of the projectionist, who naturally dislikes handling something that he does not understand, we will say that there is no reason for breaking the seal, because the only thing inside of the sealed box is a relay exactly similar to the relay in telegraphic instruments, and a small, high resistance unit. The operation of the controller is governed by changes in arc voltage. Inside the sealed box are two highly sensitive magnets, in series with each other, which are connected directly across the line in multiple with the projection arc. The strength of these magnets will, therefore, of course change with each variation in arc voltage. At the end of the magnets is an armature attached to an upright, the upper end of which is arranged precisely the same as the "sounder" of a telegraph instrument, except that one one side is a fibre insulator.

This bar is normally kept pulled away from the magnet by the tension of a coil spring attached to adjusting screw A, Fig. 217, and when in this position, it rests against the insulator. When, however, the magnet pulls the bar over toward it, its upper end makes metallic contact which completes motor circuit CD, Fig. 217, and starts the motor running. It works thus: the stronger the tension on the spring attached to adjusting handle A, the greater the force the magnets will be obliged to exert in order to pull it over and complete circuit CD, or, in other words, start motor Q running. Suppose when the arc is adjusted to the best possible condition, the voltage is 55. We then turn adjusting screw A, Fig. 217, until motor Q stops just at the point where the arc is the way we want it. We will then readily understand that under this adjustment, as soon as the carbon is consumed and the arc voltage increased, the increased strength of the magnets will pull the armature over, complete circuit CD, and start motor Q running, thus feeding the carbons together, which process will continue until the arc voltage has dropped to normal, whereupon the spring will overcome the pull of the magnets, and circuit CD will be broken.

That is the way the Peerless works. It is simplicity itself, and the device has given general satisfaction. The movement of the armature at its upper end, where the contact is made, is only .006 of an inch.

The projectionist may adjust the controller to maintain any desired arc length. The manufacturers claim the sensitiveness to be such that the actuating element will act on less than 1/5 of a volt change. We cannot vouch for this, but a change of as much as one volt will not materially affect the position of the spot at the aperture, hence will not affect results on the screen.

The gear reduction is such that the motor armature must make 6,400 revolutions to one revolution of the carbon feed handle. Inside the sealed box is also a high resistance unit, connected in series with motor Q, Fig. 217. This permits some current to enter the motor at all times when the table switch of the projector is closed, which serves the purpose of reducing to a minimum the load which the circuit breaker has to break, thus eliminating any destructive spark. The actuating element is guaranteed indefinitely by the manufacturers, so long as the seals are not broken. All other parts of the instrument are guaranteed against defective material or workmanship for a period of one year from date of sale.

WARNING.—The manufacturers report an inclination on the part of the projectionists to break the seals and attempt to improve the adjustment of the relay points. You are warned against doing this, because you cannot improve the factory adjustment, and it is not at all likely that this adjustment will in any way be disturbed by an extended period of operation.

The gap must be from .005 to .006 of an inch. Anything more than that will cause the controller to be coarse in its operation. The best thing you can do is to let those points alone, but if you feel the voiding of the guarantee is not too much of a price to pay for looking at a very simple mechanism, and you do break the seals, then by all means confine your efforts to **looking;** but if you feel it is absolutely necessary to tinker with the relay, then secure a spacing gauge .005 or .006 of an inch thick, and be sure you leave the relay with exactly that gap.

The Peerless Arc Control can only be used where direct current is employed at the arc. It must be so connected that circuit CD will receive arc voltage only, which means that the connection must be made on the projection lamp side of the rheostat, motor generator, or the mercury arc rectifier. It should, in fact, be made to the end of the projector table switch which is dead when the switch is open.

With the Power's, the Motiograph, or the type S Simplex, you disconnect the entire feed handle and rod from the lamp, and in its place attach the assembly sent with the controller. With the regular type S lamp, which has the carbon feed rod rigidly attached to the lamp, it is only necessary to remove the fibre handle and in its place attach the special feed assembly supplied for that type of lamp. Rod G is then slipped into rod B and the lower end of rod B is attached to the universal joint E, as shown in Fig. 217. Supporting rod F may be either attached to one of the lamp adjustment handles by means of clips supplied with the outfit, or you can drill a small hole in the rear lamphouse wall about five inches below the opening through which rod P passes.

Circuit CD is controlled by snap switch K. The controller may be purchased either with box L and snap switch K or without. Box L contains a fuse box and two plug fuses which protect the circuit. Snap switch K is on the outer wall of the box. If fuse box L is purchased, then circuit CD will be inclosed in flexible Greenfield conduit O. If box L is not purchased with the outfit, then it will be necessary to install a plug fuse box and a snap switch. Box L, or the fuse block, may be installed anywhere desired, but the best and most convenient way is to drill a hole large enough to admit the ½ inch chase nipple which projects through the back of the fuse box, the nut upon which will hold the fuse box in place, through the side of projector table switch box R, Fig. 217, and attach the box L on the fuse block thereto by means of suitable bolts. If box L is not purchased, then

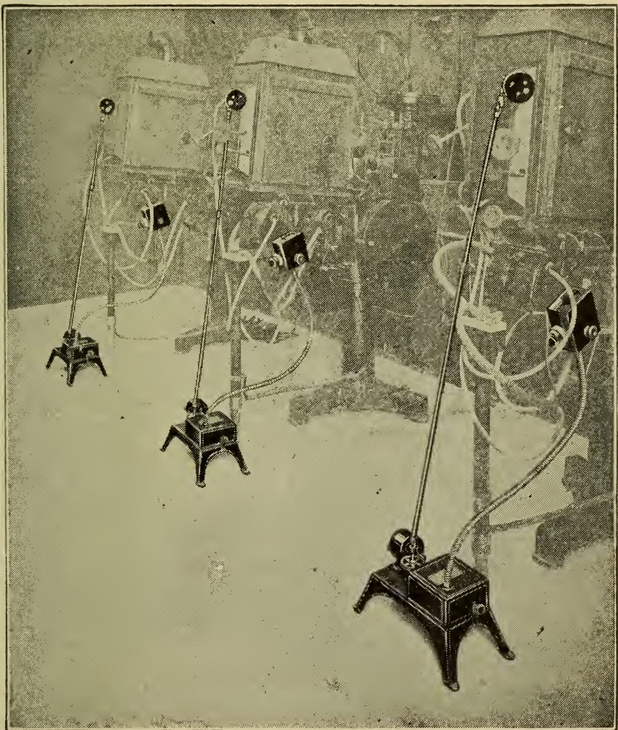


Figure 218.

circuit CD should be inclosed in flexible conduit between the controller and the fuse block.

From box L on the fuse block, the circuit CD must connect to the binding post of the projector table switch, which will be dead when the switch is open. Before installing a new trim of carbons, placing snap switch K at "open" put in the carbons and let them burn in before closing snap switch K. This is advisable because the voltage at the arc is much lower while the carbons are burning in than it is afterwards. Fig. 218 illustrates the method of installation.

LUBRICATION.—Once a week slightly lubricate the gears with a good grade of automobile grease and at the same time oil the bearings and motor.

MOTIOGRAPH MECHANICAL ARC CONTROL.—The Enterprise Optical Mfg. Company, manufacturers of the Motiograph projector, make and market a device known as an adjustable mechanical arc controller. It, together with the Motiograph lamp, is shown in Fig. 220-A. The following description will give you a working idea of the construction and operating principle of the device.

The motor, AF-1, Fig. 220-A, is mounted upon a bracket, which same is attached to the under side of the lamphouse, so that the entire device, motor and all, is readily accessible; also it is located well up out of the dust and dirt. On the motor armature shaft is a "worm," which same engages with a worm wheel attached to the outer end of shaft carrying friction disc AF-5. Friction disc AF-5 engages friction discs AF-15 and 16, and when so engaged the two latter discs are revolved. The supporting bearings for the shaft carrying friction disc AF-5 are a part of the bracket supporting the motor.

Friction discs AF-15 and 16 are mounted on carriage AF-14, the rear of which is supported on shaft AF-40; the front end is supported by rear end of shaft AF-61 by means of a tongue and groove connection.

Friction discs AF-15 and 16 are held together by the pressure of a spring. On one end of the shaft carrying these discs is a worm, which engages with a worm wheel on lower end of vertical shaft AF-27, which same connects to telescopic shaft AF-45, and by suitable means, with the carbon feed screw AL-225.

When shaft AF-40 is rotated it moves carriage AF-14, carrying friction discs AF-15 and 16 so that friction disc AF-5 is thrust further between or withdrawn from between friction discs AF-15 and 16. Since friction disc AF-5 is driven at constant speed by the motor it will be seen that rotating shaft AF-40 will have the practical effect of increasing or decreasing the speed of rotation of friction discs AF-15 and 16, hence the speed of feeding the carbons. The projectionist may therefore adjust the speed of carbon feeding at will, merely rotating the knob on shaft AF-40.

In considering this it must be remembered that the worm gears, of which there are two sets between the motor and the carbon feed screw AL-225, act to hugely reduce the speed, so that a very fine adjustment of actual carbon feeding speed is possible.

While the makers of this and other mechanical arc controls claim it is possible to run a whole trim of carbons without any attention on the part of the projectionist, it is a question if this is entirely practical. However, in any event, any adjustment that may be necessary will be very slight, provided the projectionist uses ordinary care in adjusting the speed of feeding, and the possible necessary adjustment by hand we do not regard as in any way objectionable.

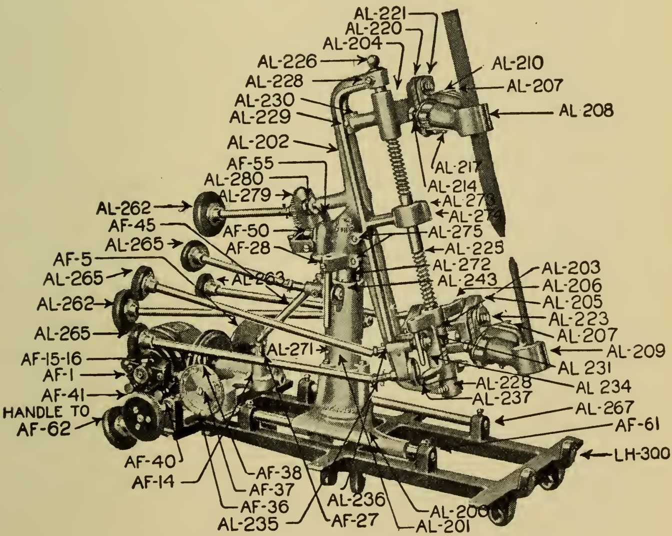


Figure 220-A.

The Mechanism

General Instructions Which Apply to All Projectors

MOTION picture projectors are very frequently sold to small town exhibitors who, in the very nature of things, are unable to employ competent projectionists, and who themselves have very little knowledge of mechanics. When a part wears or breaks they are at a loss as to the method of procedure necessary to remove same and replace it with a new part; also they are unable to make the necessary adjustments of the various parts of the projector properly.

In supplying amusement to what in the aggregate amounts to many millions of people who would otherwise be deprived of the pleasure of moving pictures, these men are doing a distinctly meritorious work. They are entitled to every bit of instruction it is possible to give them, including detailed instruction with regard to the projector mechanism, because any additional knowlege which enables them to project a better picture will add to the pleasure of all these millions of people who depend upon small town or village moving picture theatres for the only form of theatrical amusement they have.

Not only is this true, but it also is a matter of fact that even competent, experienced projectionists are offtimes at their wit's end, and commit very serious blunders by reason of the fact that but few projectionists, except those in very large cities, are able to obtain experience on all the different professional moving picture projectors. It is also quite true that even many projectionists in large cities lack expert knowledge.

We therefore have no apology of any kind whatsoever to make for supplying detailed instructions on projector mechanism. To omit them would not only be unfair to the industry as a whole, but also to the audiences who patronize moving picture theatres, and, moreover, to the projectionist himself. The claim that such instructions have a tendency to create projectionists has little weight. Even if it did the projectionist, important as is his function, is but one cog in the mechanism of the moving picture industry, and in such matters we must first look to the well-being of the industry as a whole.

There are certain instructions which apply to all projectors equally. We give them under the form of general instructions, in order to avoid consuming space by their repetition in the detailed instructions for each projector.

GENERAL INSTRUCTION NO. 1—LUBRICATION.— The modern projector is a rather expensive piece of mechanism. The purpose of oiling is to separate moving parts, and thus to reduce friction, abrasion and wear to the least possible minimum. Any oil will serve this purpose fairly well, provided enough of it be used, but in a projector mechanism the use of a minimum of oil is highly essential, because any excess will be thrown off by centrifugal force, get smeared around, and, besides making a dirty mess, will get on the films and do a very great amount of damage to screen results.

Oil that is too thin is objectionable for use on a projector, no matter what its lubricating properties may be, because it flies around and runs around too easily. Oil that is too heavy is objectionable because projector bearings are very closely fitted, and a heavy oil will not work through them fast enough, remembering that as the oil passes through a bearing it carries out with it any small parts of metal that have worn from the bearings, as well as foreign dirt which may have lodged there.

The selection of oil for use on a projector mechanism is therefore of the utmost importance, and as a rule, three different lubricants are essential: (a) a lubricating oil for the various bearings, (b) a lubricant suitable for use in the oil well of the intermittent movement, (c) a lubricant for the gears.

We are all familiar with the names of certain much advertised oils, such as "3-in-one." These oils are, in our opinion, without exception absolutely unfit for moving picture projector lubrication. Their use will, we are firmly convinced, shorten the life of a projector very greatly.

IMPORTANT RULE.—One rule with regard to projector lubrication is of huge importance. It should be rigidly adhered to by all projectionists.

Never, under any circumstances, use more than one drop of oil in any moving picture projector bearing.

Any more than one drop is very much worse than useless. One drop is ample for all purposes of lubrication in any bearing of a projector. Any excess over that amount will run out of the bearing and be thrown off, making a dirty mess, and, to some extent at least, very likely getting on the film.

In our previous books we have recommended a good grade of light dynamo oil for the lubrication of projector bearings. We see no reason for changing this recommendation. This oil can be procured, in bulk, from any dealer in oils at a very reasonable rate, but we would recommend that, where it is possible, it be purchased from the local electric power company, because they are obliged to use a high grade lubricant for their dynamos.

All, or nearly all, the various projector manufacturers themselves sell oil which they recommend for use on their projector. We can recommend these oils because, in the very nature of things, projector manufacturers would not select an oil for use on their projectors which would give other than good results.

The manufacturers are interested in seeing their projectors give good performance, and, knowing that adequate lubrication is absolutely essential to the satisfactory performance of any mechanism, naturally they will not recommend or sell anything but an oil suitable for use thereon. We therefore amend our former recommendation of dynamo oil to the extent of saying: **Use either a good light dynamo oil or the oil recommended by the maker of your projector.**

OIL WELL LUBRICANT.—The intermittent of the projector is subjected to exceedingly heavy service. Sixteen times every second the driving element strikes the driven element what amounts to a heavy, sliding blow, hence, unless it run in a high grade, suitable lubricant you may expect both these parts to wear very rapidly.

While we can recommend a heavy bodied, non-carbon oil, such as a very heavy dynamo oil, still in this particular thing **we would suggest that you implicitly follow the instructions of the projector manufacturer with regard to intermittent lubrication.** All, or nearly all, manufacturers of professional projectors have for sale a special lubricant which they recommend for use in the intermittent oil well. This lubricant has one very important peculiarity, viz.: it will not run out through the sprocket shaft bearing. It is a good lubricant for the purpose, and we recomend its use.

Never, under any circumstances, put graphite, or anything else except pure oil, or whatever is recommended by the projector manufacturer, in the intermittent oil well. Graphite is a high grade lubricant under some conditions, but it will injure or even ruin an intermittent movement, and may do it very quickly, too.

GEAR LUBRICATION.—A light oil, such as is used for the projector mechanism bearings, is not suitable for gear lubrication. Automobile cylinder oil, bicycle chain lubricant, automobile cup grease, or transmission grease, or a good grade of vaseline, is very much better. Beeswax also has been used by some, and tallow by others.

WASH OFF GEARS.—If the projector mechanism be of the uninclosed type, however, no matter what kind of lubricant is used it will collect dust and dirt constantly, which, uniting with the lubricant, forms a grinding paste. It is therefore advisable to thoroughly clean the gears of the projector mechanism at least once or twice a week. The most practical way is to have a shallow dish or pan constructed which will fit around one side of the mechanism base, under the gears. With the pan in place, while you run the projector very slowly, flood the gears with kerosene or gasoline from an ordinary squirt can. It, of course, is possible to remove the mechanism from the stand and immerse the whole thing in kerosene, giving the crank several turns while the mechanism is so immersed. This thoroughly cleanses both the gears and the bearings, but is, we think, more trouble than it is worth. If it be done, first be sure the intermittent oil well opening is closed tightly. Warning—Use kerosene, NOT gasoline.

WASH OUT OIL WELL.—The oil well should be emptied at the end of one hundred and fifty hours' run and filled with fresh lubricant.

From continued use oil becomes "poor." In other words, its lubricating powers are lessened through continued use. After emptying the oil well it is a good plan to wash it out with kerosene, being sure, however, to remove every bit of the kerosene, else it will reduce the lubricating quality of the new oil, and make it more apt to run out through the bearings.

GENERAL INSTRUCTION NO. 2.—Where the old style friction take-up is used it is of utmost importance that the take-up tension be set just barely tight enough to take up the entire reel. Any tension in excess of this is not only bad, but it is **very** bad, particularly if the old style 1½ inch reel hub be used. A moment's study of this matter will convince you of its importance. Throughout the entire process of re-winding, the take-up friction will exert precisely the same amount of pull on the spindle which carries the take-up reel. When the film first begins to wind on the hub of the lower reel, the diameter of the film roll will be less than 2 inches, if an old type reel be used, therefore the pull on the film will be very heavy. As the diameter of the film roll increases, however, the pull on the film decreases, until when the reel is full it will be very slight.

In other words, since the pull of the take-up is constant, and must be sufficient to revolve the reel when it is full, the actual pull exerted on the film at the beginning of the process of re-wind, is very many times greater than it is at the end. This means that not only is the film wound entirely too tightly at the beginning, and too loosely at the end, but also that during the beginning of the process of re-winding the pull on the film is so heavy that if there is excess tension it is quite possible the sprocket holes may be strained, or even broken, since the pull is against the lower sprocket of the projector. It is even possible, and does often happen, that the film is pulled over the lower sprocket, and the lower loop is thus lost, though ordinarily this only takes place when a bad splice comes through.

Excess tension also is apt to pull weak splices in two. It is in every way detrimental, therefore the projectionist should use every precaution to have his take-up tension set exactly right, and "exactly right" is that tension which will no more than insure completion of the process of re-winding. Of late there have been some very excellent devices invented which equalize the take-up pull throughout the process of rewinding. Also the split pulley friction take-up has been to a very great extent improved by increasing its diameter.

GENERAL INSTRUCTION NO. 3—DIRTY SPROCKETS. —It is of the utmost importance that the sprockets of the projector be kept perfectly clean. This is important for all sprockets, but particularly for the intermittent, because any dirt accumulating on the face of the intermittent sprocket will cause unsteadiness of the picture on the screen. The best method of cleaning sprockets is as follows: Procure a rather stiff bristle toothbrush, and either a wide-mouthed bottle or a small tin can with a cover. If the bottle be used, drill a hole through its cork and shove the handle of the toothbrush through, so that when the cork is in the bottle the brush will reach almost to the bottom. If a can is used cut a hole in the lid large enough to admit the brush.

Partly fill the bottle, or can, with kerosone, and once a day (oftener if necessary) examine the sprockets closely, and if there is the least bit of gum or dirt on the face of any of them scrub it off with the toothbrush wet with kerosene.

Examine your sprockets carefully at least once a day, making certain they are perfectly clean. Dirt on the intermittent sprocket will cause the picture to jump, not sometimes, but always, while dirt on the upper or lower sprocket may cause the losing of one of the loops.

It is an astonishing thing that some projectionists do not grasp the seemingly self-evident fact that the face of the intermittent sprocket, or any other sprocket for that matter, must be kept perfectly clean. We have known of a projector mechanism shipped a distance of two thousand miles to the factory the complaint being that "the picture jumped terribly." On examination the face of the intermittent sprocket was found to be covered with gum and dirt. This was cleaned off in less than a minute, and the machine tried out, with the result that the picture was rock steady. It seems unbelievable that a man with no more intelligence than this would indicate would undertake to project photoplays, and reproduce upon the screen the work of some of the best artists in the world. Imagine, if you can, sending a projector more than two thousand miles merely to have the dirt cleaned off the face of its intermittent sprocket, a thing the projectionist himself could have done in a minute with the aid of a little kerosene and a toothbrush.

GENERAL INSTRUCTION NO. 4—SPROCKETS IN LINE.—It is important that the sprockets of your projector be in perfect line with each other and with the aperture. With modern projectors there is little possibility of getting the sprockets out of line. It is, however, well to test the matter when a new sprocket is installed. I cannot give definite instructions as to how to test the lining of the sprockets, since they will vary with different makes of projector. The meaning will, however, be understood by examining Fig. 224, in which dotted line is presumed to be exactly central sidewise in the aperture and the teeth on each side of each sprocket must be equidistant from the line. This may be roughly tested, so far as the intermittent and upper sprockets be concerned, as follows: Thread a piece of new film into the projector, engaging it with the teeth of the upper and intermittent sprockets, closing the idlers. Turn the fly-wheel backwards until the film is stretched tightly. If the upper and intermittent sprockets and the aperture are in the line with each other, that fact will be evidenced by the film-edge being out of line with the tracks on the aperture plate, or the aperture being out of center in the film. If the film seems to bear equally on both edges of both sprockets, and the aperture plate tracks are not straight with the film, it would indicate the probability that the aperture plate itself is out of true. In some projectors this may be easily remedied; in others the aperture plate cannot possibly be out of true, and the indication would be that both the upper and intermittent sprockets are too far over to one side. Before making this test you should be sure the intermittent sprocket shaft is in exact alignment with the cam shaft, because if one end of the intermittent shaft be high or low, the intermittent sprocket will not be square with the film. This condition is not possible except on projectors in which either end of the intermittent sprocket shaft may be raised or lowered independently of the other end.

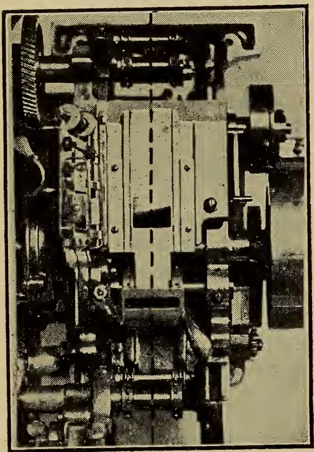


Figure 224.

GENERAL INSTRUCTION NO. 5—ADJUSTMENT OF INTERMITTENT MOVEMENT.—When the intermittent movement is on the "lock" its adjustment should be such that there will be very little circumferential movement in the intermittent sprocket, but care must be exercised that the adjustment be not made too close or else there will be undue and unnecessary friction of the parts. These adjustments are usually made when the projector is cold, and it must be remembered that under the influence of the heat of the spot, all the parts expand more or less, and that fact must be taken into consideration. If the adjustment is made close enough so that you can feel the intermittent sprocket move just the least little bit when you try to rock it with your finger, it will be correct.

A very little circumferential play in the intermittent sprocket does no harm, in fact it is necessary; excessive motion will be harmful in several ways.

Do not attempt to adjust the intermittent as above if the cam, the star or the intermittent shaft bearings are appreciably worn.

SPARE INTERMITTENT MOVEMENT.—We strongly advise the purchase of a spare, complete intermittent movement, assembled all ready to place in the projector. With some projectors the removal of an old intermittent movement and installation of a new one takes quite a bit of time. With others an old movement can be removed and a new one inserted, all ready to project the picture, in a few moments. In order to have steadiness of the picture on the screen it is essential that the intermittent movement of the projector be in about as nearly perfect mechanical condition as any mechanical thing can be. Our reason for advising the purchase of a spare intermittent (one spare for a two-projector installation will serve) is that the repair and adjustment of so delicate and essential a part of the mechanism can usually be better taken care of at the factory or service station of its manufacturer than anywhere else. Having a spare intermittent, when the intermittent of one of the projectors is in need of attention it can be pulled out, the new one put in its place and the old one sent to the factory or service station by insured parcel post, at an expense of a few cents, where it can be put into first class condition and returned. The replacement of an intermittent sprocket, star or cam, is a very delicate operation, and one which should be done at the factory or service station only.

This is particularly true in the case of the cam and star, or cam and diamond in the case of the Power's projector, because it is very difficult, not to say impossible, for the projectionist to fit these parts properly.

Never attempt to put in a new star and try to make it run with an old cam, or vice versa. If either a new cam or star is to be put in, we would by all means advise that the part it is to work with be renewed also, and that new brushings be installed as well.

It is possible for the projectionist, by intelligent and very careful work, to replace a worm intermittent sprocket. For this purpose there is a press made by V. R. Shaw, Motion Picture Projectionist, Marian, Indiana, which not only presses out the pins, but presses the shaft out of the sprocket. It is not an expensive tool, and we commend it to the favorable consideration of projectionists, though whether it will be placed in the hands of supply dealers or not we cannot, at this time, say. Another excellent plan is to get a sprocket anvil, illustrated in Fig. 225, which may be had from the E. E. Fulton Company, 3208 Carroll Avenue, Chicago, Illinois. With this it is possible to drive sprocket pins out without injuring either the pins or the sprocket. Such an anvil can be made. The drawing is full size. Never lay the face of a sprocket down on a bench and try to drive the pins out. Support the **hub** of the sprocket instead. After a sprocket has been on a shaft for some time it may stick pretty tight. The shaft, however, may be driven out without danger of injury to either it or the sprocket as follows: Open a vise about an inch. Across its jaws lay two short pieces of hardwood board, which for some projectors must not be more than ¼ of an inch thick. In the edge of one cut a notch large enough to admit the sprocket shaft. Place the sprocket with its lower edge resting on the boards, the star end hanging down between the jaws of the vise. Using a short piece of No. 6 copper wire for a punch, gently tap on the end of the shaft and drive it out, being very certain it does not fall when released.

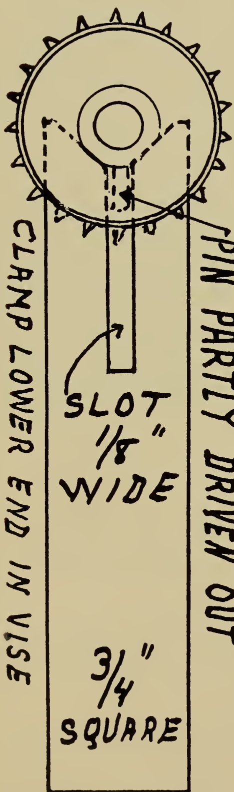


Figure 225.

When the old sprocket is removed, clean the shaft thoroughly, being certain there are no burs or sharp edges on pin holes. Wipe off perfectly clean and lubricate with good oil, after which push the new sprocket on with a twisting movement. If it sticks when partly on, pull off, clean shaft, re-lubricate and repeat the twisting movement as you push sprocket on again. These parts must and do fit with great accuracy, and the twisting is to grind down any slight over-size of shaft.

It may or may not take several removals and re-lubrications, but if persisted in the sprocket will finally be in place, and will fit accurately.

CAUTION.—Intermittent sprockets are pinned on the shaft with taper pins, the small end of which should be marked with a center punch mark. If it is not thus marked, and you cannot tell which is the small end with your naked eye, you can by using a condenser lens for a magnifying glass.

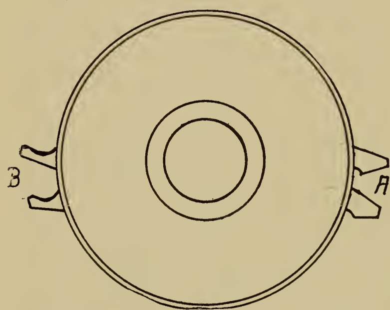
CAUTION.—Don't hammer on the small end of a taper pin with a steel hammer. Either use a punch, or if the end of the pin protrudes appreciably, lay a piece of copper on the end of the pin and start it by tapping on the copper.

CAUTION.—In replacing the sprocket be sure you get the big end of the hole in the sprocket hub opposite the big end of the hole in the shaft, and don't drive the pins in too tightly. Just set them up snug. If you drive too hard you will not only make it either difficult or impossible to remove them when the time for their removal comes, but you may spring the metal of the sprocket or shaft, and thus force the whole thing out of true. Remember that the taper of the pin is very slight, hence it is a very powerful wedge.

GENERAL INSTRUCTION NO. 6—END PLAY OF INTERMITTENT SPROCKET.—There must be no appreciable end motion of the intermittent sprocket. If there is it may produce side motion of the picture on the screen. In most modern projectors it is extremely unlikely that such end motion will develop, but if it does it must be eliminated. In some instances side play is due to the holes in the sprocket hub, in which are the pins holding the sprocket to the shaft, being worn. If there is end motion and you can find no other probable cause, remove one of the pins and examine the hole it came out of under a magnifying glass. A condenser lens will probably serve. If the hole is out of round, then the holes must be reamed out and the new pins put in. The Simplex service stations will provide a suitable reamer.

We presume other manufacturers will do the same. Be careful to remove no more than sufficient metal to make the holes perfectly round. The new pins will, of course, go in further than did the old ones, but that is quite all right.

GENERAL INSTRUCTION NO. 7—WORN SPROCKET TEETH.—Never continue to use an intermittent sprocket if its teeth have become appreciably worn, because such a sprocket is not only very likely to produce unsteadiness of the picture on the screen, but will inevitably do serious injury to the working edges of the sprocket holes, thus making it impossible under any circumstances to thereafter project a perfectly steady picture with the film that has been thus abused.



Enlarged Sprocket, Showing Hooked and Undercut Teeth.

Figure 226.

EXAMINE TEETH.—Once every week the projectionist should, using a condenser lens for a magnifying glass, carefully examine the wearing surface of the intermittent sprocket teeth. If he finds any indication of undercut, such as is shown on edges of tooth A, Fig. 226, or if he finds any indication of "hooking" of the tooth, as per tooth B, Fig. 226, the sprocket should be immediately replaced with a new one. It is not advisable to attempt to turn an intermittent sprocket around so as to use the other side of the teeth.

Worn intermittent sprocket teeth, besides setting up the probability of inducing unsteadiness of the picture, and injuring the edge of the sprocket holes of the film, have a decided tendency to cause the teeth to climb the sprocket holes, thus losing one of the loops.

The intermittent sprocket teeth do all the work of pulling down the film against the braking action of the tension shoes, hence are subject to very heavy wear. True, they are or should be glass hard, but the friction between the teeth and the film is heavy, and is confined to a very small surface only, hence it is possible the teeth may show signs of wear in a comparatively short time, **particularly if the pressure of the tension shoes be excessive.**

GENERAL INSTRUCTION NO. 8—GATE IDLERS.—Top idler on the gate, or whatever takes it place, is for the purpose of holding the film central over the aperture, and to help in preventing side motion of the film. Some of these guides have the possibility of adjustment, while in others the position is fixed, and cannot be altered. If there is an adjustment, the guides should always be kept set close enough to prevent any side motion in the film, but not close enough to cause any binding. In some of the older type projectors it is possible to get this adjustment far enough to one side that the sprocket holes will show on the screen. We believe this, however, is not possible with any modern professional projector.

GENERAL INSTRUCTION NO. 9—APERTURE TENSION ADJUSTMENT.—There is no one thing in connection with the work of the projectionist which receives less intelligent attention than the adjustment of the gate tension, or in other words the amount of pressure exerted by the tension shoes on the film at the aperture.

It is of course understood that by means of the upper and lower loops the strip of film between them is detached from the rest of the film, to the extent that it may stop and start while the rest of the film runs continuously.

The office of tension shoes (in the old types of projector there were no shoes. The flexible tension spring bore directly on the film) is twofold. First, to stop the film when the intermittent sprocket stops. Second, to hold the film perfectly flat over the aperture during its period of rest. If the tension be too weak there will be "over-shooting," which means that the film will not be stopped the exact instant the motion of the intermittent sprocket ceases, but, due to momentum, will continue slightly after the sprocket stops and possibly in varying amounts.

The effect of too much tension is (A) heavy and unnecessary wear on the mechanism of the entire intermittent movement, but particularly on the wearing surface of the intermittent sprocket teeth, (B) heavy and unnecessary wear on the delicate edges of the sprocket holes in the film, which is bad in any event, and will be increasingly injurious if the sprocket teeth are in any degree under-cut or hooked It is even possible, particularly when combined with high speed of projection, that the strain will be sufficient to split or crack the film at the corners of the sprocket holes. Once a film has been subjected to abuse of this kind it will thereafter be forever impossible to produce a rock steady picture when using that film.

Summed up, this means that the tension cannot be too slack without producing an injurious effect on the screen, and it cannot be too tight without injuring both the projector and the film itself.

HOW TO SET TENSION.—Every projector should have a tension adjustment in substantial, accessible form. The screw by means of which this adjustment is made, besides being accessible, should be located away from the heat of the spot. Adjustment of the tension cannot be made when there is an audience in the theatre. In former editions of this book instructions for making this adjustment were given which there is no reason to in any degree change or modify. They were as follows:

Thread into the projector a film, the sprocket holes of which are in good condition. Run the projector at a speed about 10 revolutions of the crank shaft per minute faster than your highest speed of projection will be. Continue this speed steadily while you so adjust the tension adjustment that the picture just begins to crawl up on the screen, which means that overshooting has commenced.

This is as accurate an adjustment as it is possible to make; also it is one which anyone can apply, always providing there is a tension adjustment on your projector. If there is no tension adjustment, then it will be necessary to bend the tension springs until the desired pressure is had. It is no easy job to do this, but it is nevertheless up to the projectionist to do it, and **any man who has not sufficient regard for the projector and films placed in his charge to at least safeguard them to the extent of properly adjusting the tension is unfit to have charge of a projection room.**

GENERAL INSTRUCTION NO. 10—EMULSION DEPOSIT.—First run films are frequently sent out with the emulsion so soft that it has a strong tendency to deposit on the face of the tension shoes, **particularly if the tension be excessive.** Projectionists are obliged to run these films, and they experience a great deal of trouble by reason of the deposit. The tendency to deposit may be increased by the too liberal use of cement in making splices. The emulsion, or a mixture of emulsion and cement forms a very hard, unyielding mass on the polished surface of the tension shoes, which, besides causing the tension shoes to jump and clatter, is likely to injure the film itself more or less seriously.

When using a first run film, the surface of the tension shoes and the aperture plate track should be carefully examined after each reel, (excess of film cement will sometimes deposit on the tracks of the aperture plate) and any deposit found thereon must be carefully removed.

BEST WAY TO REMOVE DEPOSIT.—The deposit may be removed by scraping it off with the edge of a silver coin, or by the use of some other soft metal, but the best way is to use a wet cloth. Water softens the emulsion instantly, therefore the deposit may be quickly washed off without any possibility of injury to the polished parts.

CAUTION.—Never use a knife blade, screw driver or other hard steel instrument to scrape deposit off the tension shoes or aperture plate tracks, because by so doing you will scratch the polished surface and thus increase the tendency to deposit.

Many plans have been tried for the elimination of this trouble, but the only really practical thing is the lubrication of the film track.

It is possible to make a fairly effective film track lubricator as per Fig. 77-C, Page 274.

It is even possible to reduce the trouble somewhat by rubbing the tension shoes with the end of a tallow candle before threading the projector, or by holding a tallow candle lightly against the teeth of the upper sprocket occasionally for a few seconds while the film is running.

GENERAL INSTRUCTION NO. 11—WORN APERTURE PLATE TRACKS.—In instruction number 9, we said that one of the offices of the gate tension is to hold the film perfectly flat over the aperture. This, of course, cannot be done unless the surfaces of the aperture plate tracks be themselves true and level; it therefore follows that excessive wear of the aperture plate tracks may, and probably will, cause a buckling of the film over the aperture, and an out-of-focus effect on the screen. By this we do not wish to be understood as meaning that buckling of the film over the aperture is always due to this cause, but while it may be induced by other causes, such as old, shrunken film, worn aperture plate tracks are pretty sure to produce the trouble. Buckling of the film over the aperature will cause an out of focus effect or an "in and out" of focus effect.

The projectionist should carefully examine his aperture plate tracks, with reasonable frequency, and should renew them as soon as they show any appreciable unevenness of the surface.

GENERAL INSTRUCTION NO. 12—SPROCKET IDLERS. —It is essential to proper performance of sprocket idlers that the idler set equidistant from the face of the sprocket at both ends of the sprocket, and that the distance of the idler from the face of the sprocket be a trifle more than the thickness of a film. If the sprocket idler be not carefully and accurately set as per the foregoing, there is likely to be more or less trouble, particularly at the lower sprocket. The losing of the lower loop, while not of course necessarily chargeable to improper setting of the lower sprocket idler, nevertheless is very frequently due to that cause, particularly if there is excessive take-up tension. If the lower sprocket idler be out of line with the sprocket, or too far away from the sprocket, or close enough to the sprocket to pinch the film, there will probably be trouble through losing of the lower loop.

Never allow your sprocket idler to "ride the film"—that is to say, to bear on it with any pressure. This is particularly bad if the pressure be greater on one side of the sprocket than on the other. Under that condition, the film is likely to climb the sprocket at the first bad splice.

Examine your sprocket idlers frequently, and make sure that they are turning freely. If they do not they will soon develop a flat spot, which sooner or later means trouble. All professional projectors have an adjustment by means of which the projectionist may determine the distance of the idlers from the face of the sprocket. A fairly good plan is to place two thicknessess of film on the sprocket, and then adjust the idlers so they rest on the film; with this adjustment and only one thickness of film, the idler should be about the right distance from the sprocket.

GENERAL INSTRUCTION NO. 13—LINING CAM SHAFT.—When using a projector in which the adjustment between the star and cam is accomplished by turning an intermittent sprocket shaft bearing at either end, great care should be taken that the intermittent sprocket and the cam shaft are kept in perfect alignment with each other. The position of the cam shaft is not adjustable, but the sprocket shaft is raised or lowered by turning the bearing bushings, and it is possible, by turning one bushing more than the other, to get the sprocket shaft lower on one end than the other, under which condition the sprocket will not be square with the film, and the teeth on one side of the intermittent sprocket will have to do most of the work in pulling the film down. This matter should be watched very closely when an adjustment is made.

GENERAL INSTRUCTION NO. 14—MAGAZINES IN LINE.—With modern projectors the position of the upper and lower magazines are fixed, and they cannot be located wrongly. With some of the older types, however, it is quite possible to get the magazine out of line sidewise with the sprockets, and this should be guarded against, because a magazine out of line is likely to cause a great deal of trouble, in several different ways. If the lower magazine is out of line, the take-up will pull the film sidewise, which will create an added tendency to lose the lower loop. If it be the upper magazine that is out of line, the film will not approach the upper sprocket squarely, which may cause trouble, and in any event it will rub against the metal of the fire trap with possible damage to the film itself, and certain damage to the trap.

GENERAL INSTRUCTION NO. 15—PROJECTION ROOM REELS.—We very strongly recommend that the projection room have a full complement of reels, and that the exchange reels be used only in the upper magazine for the first run of the film after it is received, and in the lower magazine for the the last run of the film before shipment.

THE CONDITION OF REELS SENT OUT BY EXCHANGES IS, ALL TOO OFTEN, NOTHING SHORT OF AN OUTRAGE.

They are more often than not a cheap, flimsy affair, with a hub and spring clip in more or less wretched condition, with their sides bent and wobbly, and very frequently they have sharp edges of metal caused by the punchings of the reel sides when they are made, which to a greater or less extent injures the film.

Only projection room reels should be used for projection, and they should be kept in first class condition. Use of reels in bad condition causes an enormous amount of damage to films, both in rewinding and in projecting. Reel sides very often rub on the magazine side, thus setting up braking action, which, under some conditions, will pull the film in two. See Page 322.

Theatre managers will do well to understand the simple fact that all unnecessary damage done to films while in their own or any other theatre, becomes, of necessity, part of the overhead expense in film distribution. If, through carelessness in handling films on bad reels, etc., a heavy decrease in the life of the film is caused, then whatever the damage is, it must, and inevitably will be added to the film rentals. We venture the assertion that if theatre managers used a little common sense, and insisted that the films be handled carefully, and on reels that are in good condition, and that rewinding be done at the rate of six or seven minutes to the reel, instead of one or two minutes, film rentals would within a short time be reduced in a very noticeable amount.

GENERAL INSTRUCTION NO. 16—UPPER MAGAZINE TENSION.—In professional projectors there is usually some sort of tension device in the upper magazine, the purpose of which is to prevent the reel from revolving too freely. It is important that this device be so designed that it will not catch on loose screws or reel hubs, and that the tension be of sufficient amount to just barely keep the film taut at all times, and stop the reel instantly when the projector stops. The importance of this latter will be realized when we consider that if the reel revolves too freely, and the projector be stopped when the upper reel is three-quarters or more emptied, and the reel continues to make one or two revolutions after the projector has stopped, thus unwinding considerable slack film, when the projector is started it is likely to come up to normal speed before it takes up all the slack film, whereupon the upper reel will be subjected to a sharp jerk, which may pull a splice in two, rip out sprocket holes and lose the upper loop, or even pull the film itself in two.

GENERAL INSTRUCTION NO. 17—FILING THE APERTURE.—It is sometimes necessary that the form of the projector aperture be changed, in order to parallel the sides of the screen image when there is a pitch in the projection. You will find directions for doing this on Page 257.

GENERAL INSTRUCTION NO. 18.—The Standard aperture now in use and approved by the Society of Motion Picture Engineers, is .6795 (87/128) of an inch high by .9062 (29/32) of an inch wide.

GENERAL INSTRUCTION NO. 19—MAGNETIZED SCREW DRIVER.—The projectionist will find a strongly magnetized screw driver a great convenience, particularly when handling small machine screws, since they may be removed and inserted without danger of dropping them.

GENERAL INSTRUCTION NO. 20—THREADING THE PROJECTOR.—All projectors thread precisely alike, so far as the operating principle is concerned.

There are differences in the mechanical application of the principle but the principle itself is always the same. The film comes down out of the upper magazine through a fire-trap,

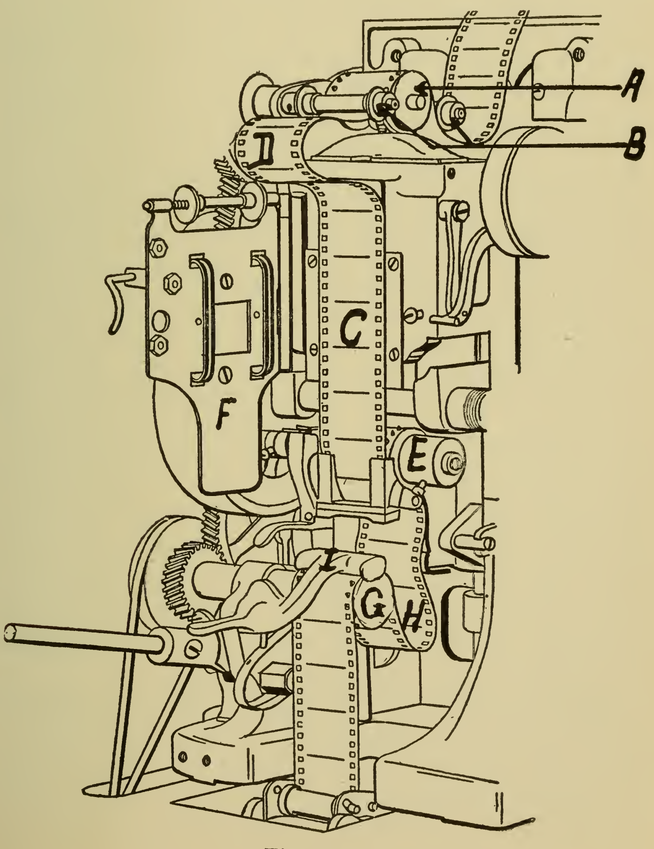


Figure 227.

engages with upper sprocket A, Fig. 227, and is clamped thereby to one or more idler rollers, B. The film may pass over the upper sprocket as is shown in Fig. 227, or it may pass under the sprocket. Having been attached to upper sprocket A it is carried down over the aperture, as shown at C, with sufficient slack film to form upper loop D. The film is then engaged with intermittent sprocket E, and is locked thereto by the idler, which may be a roller or may be a shoe, after which the gate F is closed and locked shut. The film is now engaged with lower sprocket G, Fig. 227, sufficient slack film being left to form lower loop H, Fig. 227. The film is locked to lower sprocket G by means of idler I, after which it is carried down through the fire trap into the lower magazine and attached to the take-up reel. Upper and lower loops D and H must have sufficient slack film so that when the intermittent acts the film between the upper sprocket and the top of the gate, and between the intermittent sprocket and the lower sprocket, will not be pulled tight. The reason for these loops is that whereas upper sprocket A runs continuously, pulling the film out of the upper magazine and feeding it to the intermittent, and lower sprocket G runs continuously, taking the film away from the intermittent sprocket and feeding it into the lower magazine, sprocket E only acts intermittently, so that the strip of film between the top of the gate and the intermittent sprocket is standing still about four-fifths of the time, and moving at high speed the rest of the time, its high speed while in movement exactly equalling the total travel of the rest of the film. In other words, while upper sprocket A feeds three-quarters of an inch of film in a given time, which we will assume to be 5/80 of a second, the film between the upper end of the gate and the inmittent sprocket moves exactly three-quarters of an inch in 1/80 of that time, standing still 4/80 of the time. The offices of the upper and lower loops are to enable the constantly running film above and below to join with the intermittently running film over the aperture.

GENERAL INSTRUCTION NO. 21—THREAD IN FRAME. —Modern practice demands that the film be threaded in frame. By this it is meant that when threading the projector the projectionist must so place the film that one whole photograph will register exactly over the aperture, neither the upper or lower frame line being visible. This can be accomplished in several ways. The projectionist may look through the lens while placing the film, or he may hold a lamp in front of the lens and look through the other way. At least one projector manufacturer, the Power's, places a small battery lamp inside the mechanism, which may be temporarily lighted while framing.

No matter what plan be adopted for accomplishing the purpose, however, the picture should never be projected to the screen out of frame. Such work is crude in the extreme, and brands the projectionist as a very slip-shod, careless workman, except possibly in one projector installation where threading must be done in the absolute minimum of time.

GENERAL INSTRUCTION NO. 22—REVOLVING SHUTTER.—The revolving shutter is an extremely important and integral part of the optics of the projector. Its function is to close the lens, or, in other words, to cut off the light from the screen during the time the intermittent movement is acting and moving the film over the aperture.

It is absolutely essential to intelligent work that the projectionist have a complete understanding of all those various things relating to and connected with the revolving shutter.

To begin at the beginning, there is no such thing as a "moving picture," or a "motion picture." What we term moving or motion pictures, is really nothing more or less than the display of a series of snapshot photographs, taken at the rate of sixteen or more per second, and displayed to us so rapidly that one photograph blends into the next, thus forming the optical illusion of motion.

Beginning at a frame line between two pictures, measure one foot of film, and you will find thereon precisely sixteen complete pictures. Except in the matter of size these pictures in no way differ from ordinary snapshot photographs. They are presumed to be taken at the rate of sixteen per second, but as a matter of fact in modern practice the speed of taking very frequently exceeds this considerably. As the film passes through the projector these photographs are, by means of the intermittent mechanism, successively posed over the aperture, and while so posed are projected, one after the other, to the screen. The purpose of the intermittent movement of the projector is to pull the film down across the aperture precisely three-quarters of an inch, and to leave it over the aperture for an infinitesimal period of time. At the rate of sixty feet of film per minute, the time each picture remains over the aperture is one-sixteenth of a second, less the time it requires to move the film down, which ordinarily, is about one-fifth of one-sixteenth of a second, or 1/80 of a second. We may therefore say that at the rate of sixty feet per minute, 4/80 of a second is consumed by the actual projection of the picture, and 1/80 of a second is consumed in the removal of one photograph and the substitution of the next —in the pulling down of the film.

WHY THE LENS MUST BE CLOSED.—If, however, the change of photographs over the aperture be made with the light projected constantly to the screen, there will be streaks of white up and down across its surface. The reason of this is as follows: White makes a greater impression on the eye than do colors of less brilliancy. Suppose we project a moving picture to the screen without any revolving shutter—with the light projected constantly. Suppose in this scene there is a man in evening dress, with a broad expanse of white shirt front. The dark colors of the evening dress make little impression on the eye, but the dazzling white of the shirt front makes a very great impression, and as the film moves and the figure of the man in one photograph is substituted for the figure of the man in the next, as the figure of the man in the first photograph is jerked down out of the way the eye will see and follow the brilliant whiteness of the shirt, though it will not see and follow the darker clothing. Also, as the other figure comes into view the eye will quickly catch the white of the shirt, and not see the dark clothes until the figure comes to rest. We would therefore have a white streak across the screen. These white streaks are technically known as "travel ghost."

Due to this phenomenon, it is necessary that the lens be closed during the time the intermittent movement is in action and the film moving, and this is the function performed by the revolving shutter.

The revolving shutter of a projector (except in the case of the one and one-and-a-half-to-one shutter, the action of which will be explained further on) revolves exactly once to every complete cycle of the intermittent movement. If a certain edge of the master blade of the shutter occupies a certain position with relation to the lens when the intermittent begins to act, it will occupy precisely the same position the next time the intermittent begins to act, having meanwhile made one complete revolution.

Without any film in the projector, open the gate, block the automatic fire shutter up and project the white light to the screen while you run the projector **very** slowly. You will observe that during the time the intermittent sprocket is in motion the master blade of the revolving shutter cuts off all the light from the screen. You will also observe that, according to whether you have a two-wing or a three-wing shutter, all the light is cut off from the screen two or three times during each complete cycle of the intermittent, or during each revolution of the shutter.

In projection, what we therefore have on the screen is a succession of flashes of more or less brilliant light, and a succession of almost equal periods of time when no light from the lens reaches the screen.

After running very slowly, as above directed, gradually increase the speed of the projector and you will find that when you get up to normal projection speed there will be an **apparently** uninterrupted screen illumination.

WHY MORE THAN ONE BLADE.—What we call "flicker" is the visibility of the period during which the screen is dark. The revolving shutters of all motion picture projectors have more than one blade. The reason for this is that, since light interruptions must be at the rate of 36 or more per second in order to render them invisible, the one-blade shutter would not be practical, because the light interruptions would come too far apart. As already explained, in motion picture projection the screen is alternately more or less brilliantly lighted and totally dark, insofar as light from the lens is concerned.

FLICKER.—The human eye is a peculiar instrument. It will transmit to the brain, as separate impressions, a certain number of impressions per second. Beyond that number, the impressions become merged into each other, so that the effect is that of continuity. This involves what is termed "persistence of vision," which is the peculiarity of the eye which makes the illusion of "moving pictures" possible. If the flashes of light and darkness come too far apart, or if they be disproportionate to one another, then the eye will perceive them. Under this condition persistence of vision operates incompletely, and instead of the illusion of even, steady illumination, the recurring flashes of light and darkness will be perceived in the form of what is termed "flicker." Flicker is a very serious matter indeed, in that it causes eye strain exactly in proportion to its amount. If excessive the strain on the eyes is very great and very highly injurious. Experience has taught that with a low illumination value, such as is represented by an ordinary cloth screen and an arc lamp using 25 amperes, the rate of interruptions of the light may be as low as 36 per second without flicker being objectionably visible. With a more brilliant illumination, however, such as is had with a brilliant screen surface and 60 or more amperes of current, we find it is necessary to increase the interruptions to between 55 and 60 per second in order to render them invisible, or in other words to obtain the effect of even, continuous screen illumination.

MASTER BLADE.—The blade which cuts the light from the screen while the intermittent sprocket is moving is variously called the "master" blade, "working" blade, "main" blade and the "interruptor" blade. We have selected **master blade** as the most appropriate term. In addition, the shutter has one or more additional blades, commonly termed "flicker" blades, the purpose of which has already been described.

The function of the master blade is to close the lens while the intermittent movement is in action. When the intermittent sprocket starts to move the master blade of the shutter comes in front of the lens and entirely shuts off the light from the screen, passing from in front of the lens and permitting the passage of the light to the screen the instant the intermittent sprocket comes to rest. From this we see that, in theory, the shutter must be so set or "timed" that its master blade will cover the lens, and shut off the light from the screen at the exact instant the intermittent begins to move, and uncover the lens at the exact instant the intermittent sprocket comes to rest. This, however, is to some extent modified. As a matter of fact the lens need be only about three-quarters closed when the intermittent sprocket begins to move, and may still be slightly open when the intermittent movement ceases. This is because of the fact that, with the lens three-quarters closed, the light on the screen is very dim, and the impression on the eye therefore diminished to a point where the movement of the picture over the aperture cannot be perceived. If, however, the timing of the shutter be such that the lens is open too much, either when the film starts to move or is coming to rest, travel ghost will result.

SHUTTER BLADE WIDTH.—What may be termed the optical balance of the revolving shutter has directly to do with the width of the shutter blades with relation to each other, and with relation to the light openings. It is a well established fact that a three-winged shutter having three blades of equal width with each other, and of equal width with the light openings, produces the best effect in that a flickerless picture can be had at a lower speed of projection than with any other available shutter.

A shutter of this kind cannot be used except under certain circumstances which will be explained under "intermittent speed and the shutter." It has been very thoroughly demononstrated that a three-wing shutter with the flicker blades of different width than the master blade, and with the light openings of different widths, produces an excellent effect, but this unbalancing may only be done in a certain prescribed way, one feature of which is that on either side of the master blade there shall be a comparatively wide opening, and between the two flicker blades an opening of relatively narrow width.

INTERMITTENT SPEED AND ITS EFFECT ON THE SHUTTER.—To the uninitiated it may seem a very simple matter to have a 50-50 shutter, i.e., a shutter in which all blades are of equal width with each other and with the openings, but as a matter of fact, it is not. As has already been pointed out, the master blade of the shutter must be wide enough to cover about three-quarters of the lens opening, or to cut about three-quarters of the light beam when the intermittent sprocket starts to move, and still have about three-quarters of the beam covered when it comes to rest. Remembering that the shutter revolves once to every cycle of movement of the intermittent, it will be seen that the longer the time consumed by the intermittent in movement, the wider must be the master blade of the shutter.

In other words, the shorter the period of time the intermittent is in movement with relation to the time it is at rest, the less width of master shutter blade is necessary. Conversely, the slower the movement the wider the master blade must be.

The correct way of describing the speed of the intermittent movement is in degrees. The driving member (cam) of the intermittent movement is circular, and revolves continuously. Every circle is divided into 360 degrees. If the driven member (star) is engaged with the driving member (cam) and in movement during 60 degrees of the revolution of the cam, then the movement is a "60 degree movement," corresponding to a five-to-one movement, because the total cycle of movement is divided into six periods, one of which (60 degrees) represents the time during which the star and intermittent sprocket will be in motion. A true 60 degree movement should allow us to have a 50-50 three-wing shutter because there are three wings and three light openings, or in other words, 6 divisions, and since the time of movement itself is equal to one of the six periods, the shutter blades and the shutter openings may all be equal with each other, always provided there be no lost motion in the mechanism.

NOTE: This is not strictly correct except in theory because of the fact that the lens has considerable diameter the greater part of which must be covered at opening and closing.

In considering the speed of the intermittent we have only to determine whether it is a "six-to-one," a "five-to-one" or whatever it may be, and then divide 360 by the number of cycles in the movement (a five-to-one is, for this purpose, a six-cycle movement, a four-to-one a five-cycle movement and so forth) in order to reduce the matter to degrees. For instance, with a four-to-one we have $4+1=5$, and $360 \div 5=72$, therefore the four-to-one is a 72-degree movement. With such a movement the intermittent would be in action 72 degrees of the entire cycle, and the master blade of the revolving shutter would have to be 72 degrees wide if the light beam had no diameter and if there was no lost motion in the gearing between the intermittent and the shutter. As a matter of fact, however, a sufficient width would have to be added to the master blade to cover about three-quarters of the diameter of the light beam, and to allow for lost motion, so that a four-to-one movement would mean a very bad optically balanced revolving shutter, which would set up tendency to flicker at low speeds, and cut off a very great percentage of the light. The width of such a blade is easily calculated, as follows: Measure distance center of shutter shaft to center of diameter of projection lens. Multiply this measurement by two. Multiply that result by 3.1416 and divide that result by five, or the total number of cycles in the movement, meaning that if it be a six-to-one movement, then the divisor would be seven. The result will be the necessary width of master blade in inches at center of light beam, measured on the arc of a circle, if the light beam had no diameter.

It must be remembered that whereas we may not hope to have a revolving shutter cut much less than fifty per cent. of the light, still we may have it cut decidedly more than fifty per cent., and the nearer we can approach to the best possible condition the greater the percentage of the light we will be enabled to get through to the screen, and the better will be the condition as regards flicker.

LIGHT BEAM DIAMETER.—From the foregoing it will be observed that the diameter of the beam of light at the point at which it is cut by the revolving shutter is a matter of much importance, since the wider the light beam the greater length of time will be required for the shutter blade to cut through it, therefore the wider must be the master blade of the shutter.

To grasp the meaning of this, remember that the master blade of the shutter travels at a uniform rate of speed, consuming, let us assume, 5/80 of a second in making one complete revolution. It will therefore require a longer space of time for the edge of the blade to cut through a beam two and one-half inches in diameter than it will to cut through a beam one inch in diameter. Also it is evident that since the speed of the blade, as measured in inches per second, increases directly as the distance from the center of the shutter shaft is increased, the greater the distance from the center of the shutter shaft to the center of the light beam, the less time will be consumed by the edge of the master blade in cutting across a beam of given diameter. Therefore the greater the distance from the center of the shutter shaft to the center of the light beam the less important increased diameter of the light beam becomes.

Figure 228 shows the effect of added distance center of shutter shaft to center of light beam. At 2 45/64 of an inch a 1.5 inch circle occupies 32 degrees and 12 minutes. At 3 17/64 inches the same diameter circle covers only 26 degrees and 28 minutes, while if the distance be 3¾ inches the same circle occupies only 22 degree and 54 minutes. A 1.5 inch circle represents what is popularly known as a "quarter size lens." From this we see that added distance from center of shutter shaft to center of light beam makes for better conditions as to width of master blade of revolving shutter.

No matter what the distance may be, however, the less the diameter of the light beam the quicker the blade will cut across it, therefore since the master blade must cover three-quarters of the beam when the film begins to move, and continue to cover three-quarters of it until the film has stopped, it is apparent that the less the diameter of the beam the narrower may be the master blade, therefore it follows that:

The shutter blade should be set at the narrowest point of the light beam in front of the projection lens.

We therefore see that insofar as concerns necessary width of the master blade there are three governing elements, viz.: speed of intermittent movement, distance from center of shutter shaft to center of light beam and diameter of light beam.

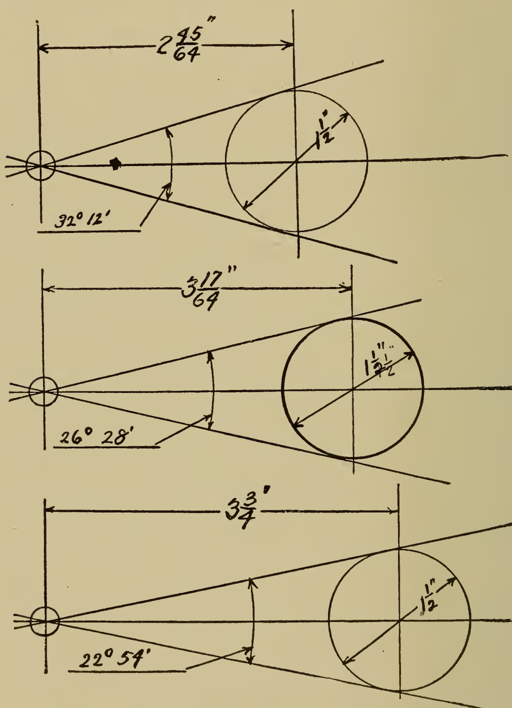


Figure 228.

AERIAL IMAGE.—The front surface of the converging condenser lens is focused at a point in front of the projection lens, except in the case of very short focal length projection lenses, in which case the image may be inside the lens barrel. The distance the aerial image will be from the projection lens will depend upon the distance of the condenser from the projection lens and the focal length of the projection lens itself. As a general proposition the revolving shutter should be set at the point of the aerial image. This does not, however, always hold good.

TO FIND THE IMAGE.—The location of the proper shutter position may be found in three different ways, as follows: (a) place a metal plate, in the center of which is a hole about one-quarter of an inch in diameter, over the face of the converging lens and project the white light to the screen. Blow smoke in front of the projection lens, and you will see that the resultant beam gradually narrows down and then spreads out again. The correct shutter position is at the narrowest point. (b) Project the white light to the screen and slowly pass some opaque object down through the light beam at varying distances in front of the lens. You will find a point at which either two shadows appear simultaneously on the screen, one at the bottom and one at the top, or else the whole screen "dissolves" into darkness. In the first case the point at which the shadows meet exactly in the center of the screen is the correct shutter position. In the second case the point at which the dissolving effect is most perfect is the right place. (c) Project the white light to the screen and hold a piece of black paper or some very dark colored, non-gloss object in the light beam in front of the projection lens, moving it slowly away from the lens until a sharp image of the converging lens of the condenser appears thereon. This test may be made more accurate by first printing some word on the face of the converging lens, using ordinary ink, and then focusing the printing.

The last method locates the aerial image and you can see at a glance whether it is advisable to set the shutter at that point or not, because you can measure the diameter of the beam at that point. If the beam at that point is either more narrow, or even as narrow as it is at any other point, then that is the place for the shutter, but if at a point nearer the lens the beam is more narrow (as is the case under some conditions) then the shutter should be set at the most narrow point of the beam.

DISSOLVING EFFECT.—The reason we say the revolving shutter should be set at the aerial image unless the beam be actually of greater diameter at the image than it is nearer the lens, is because of the fact that at the aerial image there is a dissolving effect, which may or may not enable the use of a less width of master blade. In any event, we believe it will produce a better effect.

THE WHY AND WHEREFORE.—Remember this. There is no manner of use in setting your shutter at the most narrow point of the light beam unless you take advantage of the opportunity that act affords, which is to reduce the width of the master blade. MERELY TO CHANGE THE LOCATION OF YOUR SHUTTER FROM A WIDER TO A MORE NARROW POINT IN THE BEAM HAS NO EFFECT WHATEVER except that if you have travel ghost it may be made less or eliminated entirely by moving the shutter to where the beam is more narrow—has less diameter.

The gain is just this: If your shutter is cutting the beam, without travel ghost at a point at which it, the beam, is wider than it is at some other point, then if you change the location so that the master blade cuts the beam at a more narrow point you can trim something off the master blade, thus enabling you to work more efficiently—to cut a less percentage of the light, and to obtain a better optically balanced shutter.

HOW TO TRIM SHUTTER BLADE.—There is a right way and a wrong way to do everything. After you have located your shutter at the narrowest point of the beam, the next thing is to determine how much can be trimmed off the master blade, and while you can probably estimate the amount pretty closely by slowly revolving the shutter and seeing where its edge is with relation to the light beam when the intermittent starts and when it stops, still if you get too much trimmed off your shutter blade is ruined. It is therefore advisable to proceed as follows: Get from a print shop a piece of stiff card-board about twelve inches square, such as heavy business cards are printed on. Remove the revolving shutter from its hub. Lay the metal blade on the paper and trace its blade edges thereon, afterwards cutting the paper so that you have a paper shutter with blades and openings exactly the same width as those of the metal blade. Never mind the outside rim. You may not think it, but if you are careful not to bend the paper so that you wrinkle it, such a paper blade will run for weeks, or even months.

Now place your paper blade in the hub, put it on its spindle and set the shutter correctly, though the necessity for setting may be avoided by making a mark on the hub of the shutter and on the metal blade before removal, and then making a mark on the same place on the paper blade, setting the two together when you assemble the paper blade and the hub.

Having installed your paper shutter, gradually trim off just a little bit at a time from one edge of the master blade until a tiny bit of travel ghost appears. Next trim off a little at a time from the other edge of the blade until a little bit of travel ghost appears. Having done this, remove the paper blade, lay it on the metal blade and cut the metal blade so that it is just a little wider on each side than the master blade of the paper shutter. This added width will kill the travel ghost, unless you have trimmed down too much on your paper master blade. You can now re-install the metal blade with the assurance that it is cutting the least possible percentage of the light.

Having done this, it is well to consider carefully whether a corresponding amount can be taken off the flicker blade. If the flicker blades are already more narrow than the master blade, then we would not advise this, and this is the condition you will probably find with the three-wing shutter. With the two-wing shutter the blades will probably be the same width, in which event you can trim off the flicker blade edges as much as you did off the master blade.

SHUTTER AND LOCAL CONDITIONS.—It is a very serious mistake to assume that the revolving shutter sent by the projector manufacturer is necessarily correct. It usually is not correct, though that is no fault of the manufacturer, who cannot possibly know under what local conditions any given projector will be obliged to work.

The manufacturer usually sells his projector through supply houses. Any given projector may have to work under a local condition requiring either a very short focal length or a very long focal length projection lens, and a projection lens of maximum or minimum diameter. The manufacturer, therefore, is compelled to send a revolving shutter which will prevent travel ghost under any except the very worst conditions. The dealer (supply house) usually knows little, and perhaps cares less about the optics of projection, therefore he is unable to determine what particular shutter blade width will be required under any given local condition.

It is up to the projectionist himself to fit the revolving shutter to the local condition, and any projectionist who is unable to do this, and to do it intelligently, is not a compe-

tent projectionist. He cannot get the best results except where, purely by chance, the shutter sent happens to fit the condition under which it must work.

We might add that:

Tendency to flicker increases with screen brilliancy and with the size of the picture. Conversely, it decreases with decrease in screen brilliancy and decrease in size of picture.

THE SHUTTER AND ALTERNATING CURRENT.—Where 60 cycle A. C. is used at the arc the use of the three-wing shutter is inadvisable for the following reasons: 60 cycle A. C. reverses its direction (alternates) 120 times per second, or 7,200 per minute. When a projector running at the rate of 60 feet of film per minute is equipped with a three-wing shutter, the light is cut 2880 times a minute. Half of the alternations per minute is 3,600, and if the cycle of the current happens to be not quite 60 (as often is the case) but 55 to 58 instead, it would require but just a little over-speeding of the projector to bring the wings of the shutter into synchronism with one side of the alternations. Under this condition, if the wings happen to cut the light at the point of its greatest brilliancy (See Fig. 4, Page 16), the brilliancy of the light on the screen would be diminished by probably one-half, or maybe even more. And this is what very often does take place where an attempt is made to use a three-wing shutter in conjunction with a 60 cycle A. C. projection arc. The net result is that screen brilliancy will die down and come up time after time, and in a way which is very mysterious to the uninitiated. This is because of the fact that in order to dim the light the shutter must be precisely in synchronism with the alternations, and while this may occur, it is not at all likely the synchronism would be long maintained because an almost infinitesimal variation of the speed of the projector would throw the shutter out of synchronism with the alternations, with result that the screen brilliancy would come back to normal. Put in simple words the effect of this is that screen brilliancy will alternately diminish and increase; decreasing when the shutter blades happen to be in synchronism with the one side of the alternations, and increasing when they are not.

TWO-WING SHUTTER FOR 60 CYCLE.—For the foregoing reason it is advisable that a two-wing shutter be used with 60 cycle A. C., unless the speed of projection be such as will preclude the possibility of the shutter, blades and alternations getting into synchronism.

TWO-WING AND THREE-WING SHUTTERS.—Except in the case of 60 cycle A. C. we advise the use of the three-wing shutter, provided the condition is such that it can be at least fairly well optically balanced. It is true that as a general proposition the two-wing shutter will cut a somewhat less percentage of the light than the three-wing shutter, but it is also true that with modern brilliant projection it is seldom possible to run a picture at normal speed when using a two-wing shutter, without producing flicker.

It does not necessarily follow that under all conditions the three-winger will produce appreciably less flicker at the given speed than the two-winger. We would suggest to the projectionist that he test the matter by installing a three-wing shutter and getting it into the best condition the local condition will allow. Project white light to the screen and find out how low a speed it can be run at before flicker appears. Then put on a two-wing shutter and make the same test. If the two-wing shutter produces no flicker at the lowest speed you use, then the two-winger is to be preferred, but if it does produce flicker at your lowest speed, then the three-winger is to be preferred, because you can get all the really necessary screen brilliancy with it, and current is cheaper than flicker. Also it is better to have photoplays run at the proper speed, even though it be at the expense of some screen brilliancy.

We have explained all this at considerable length in order to give projectionists a clear understanding of the various points involved.

SETTING THE SHUTTER.—The setting of the revolving shutter is to the novice a very mysterious operation. It is, however, almost childishly simple once the underlying principle is understood. The master blade of the revolving shutter is, or should be, stamped with some distinguishing mark. If it is not, then you are safe in selecting the widest blade as the master blade. Loosen the shutter so that it may be revolved by pulling a little while you hold the projector fly-wheel stationary. Turn the fly-wheel until the intermittent sprocket is just barely ready to move, pull the shutter around in the direction it normally runs until its edge covers about three-quarters of the lens, tighten the holding screws, but not so much that you cannot pull the shutter around on its hub or shaft by exerting a moderate amount of force. Thread a film into the projector, preferably one having a white lettered title with black back ground. Project it, and if there are white streaks up and down from the letters, or from white objects in the picture, move the shutter slightly by pulling it around. If this makes the matter worse, then you have moved it the wrong way. Move the shutter until the white streaks disappear, whereupon you are all right. That is all there is to "setting the shutter."

If there should be travel ghost both up and down it is evidence that the master blade of the shutter is not wide enough. A condition of this kind may be eliminated by riveting a small, light piece of sheet metal to each edge of the shutter blade (each edge to preserve the balance) or by

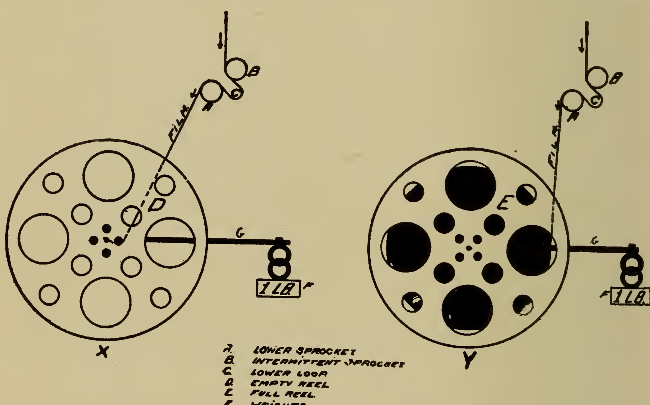


Figure 229.

moving the shutter to a more narrow point of the light ray, if it is not already at the narrowest point.

ONE-AND-A-HALF-TO-ONE SHUTTER.—This type of shutter is in effect a three-wing shutter, though it has but two blades. This is by reason of the fact that instead of revolving once to each complete cycle of the intermittent, as do other shutters, it makes one-and-a-half revolutions to each cycle of the intermittent. This means that if we number its two blades 1 and 2, and No. 1 is master blade at the movement of the intermittent, No. 2 acts as flicker blade and No. 1 does also, No. 2 coming in front of the lens as master blade at the next movement of the intermittent. This type of shutter has the advantage of high speed, which causes the edges of the master blade to cut across the light beam faster, hence increased diameter of beam is not of so much importance as with the regular type shutter. Beyond this we do not feel it to be the province of this work to discuss the relative merits of the two types. The Baird projector uses the one-and-a-half-to-one shutter.

GENERAL INSTRUCTION NO. 23—TAKE-UP.—Most modern projectors are equipped with a take-up device which more or less automatically equalizes the pull on the film, and that a very efficient equalizer is essential is made evident in Fig. 229 in which A represents the lower sprocket of the projector. Suppose with the film attached to the one and one-half inch diameter hub of an ordinary reel as per Fig. 229, and that a lever, G, be attached to the shaft carry-

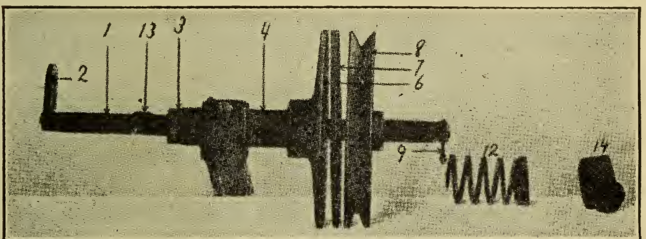


Figure 230.

ing the reel, if we place a one-pound weight at the end of the lever, it is very evident that the amount of pull on the film at X will be very many times more than the pull on the film at Y, and there lies the kernel of the take-up nut. The lower, or take-up reel is driven by the projector mechanism which runs at a continuous and presumably steady rate of speed, feeding sixty or more feet of film to the take-up reel per minute. You will readily see that under condition X, the reel will have to run very fast as compared to its necessary speed under condition Y in order to wind up the film. We see from this that the take-up reel which is driven by a power having steady speed, must itself run at a speed varying from very fast to very slow, which means there must be slippage somewhere between the driving and the driven members.

One way of accomplishing this is shown in Fig. 230, in which 8 is a pulley driven by a belt connecting with the projector mechanism, 1 is a shaft upon which this pulley rides. Pulley 8 is not attached to the shaft, but revolves freely thereon. Six is a cast iron disc attached to shaft 1 by means of a pin or set screw, so that the two must revolve as one member. Thirteen is the key which locks the take-up reel to shaft 1, and part 2 is the lock which holds the reel on the shaft. Between pulley 8 and disc 6 is a washer, 7, made of fiber. The action is as follows: Spring 12 is placed on the end of shaft 1 and against pulley 8. It is followed by collar 14 in which is a set screw. It will readily be seen that pulley 8, disc 6, and washer 7 will be clamped together by the pressure of spring 12, and that the amount of pull pulley 8 will exert on disc 6 through washer 7 before it will slip on washer 7 will depend upon the amount of pressure spring 12 exerts, which same may be altered by altering the position of collar 14.

This is the old style friction take-up; its trouble is that it must be set tight enough to revolve the reel under condition Y, which means that it will exert a very heavy pull on the film under condition X, Fig. 229. All the old style take-up did was to allow sufficient slippage between drive-wheel 8 and disc 6 to accommodate the slowing up of the reel as the film roll grew larger. This condition has the objections that it (a) tends to cause the losing of the lower loop, (b) it exerts an unnecessary and highly injurious strain on the perforations of the film, (c) it has a tendency to pull weak patches in two and (d) it has a very decided tendency to scratch the first hundred feet of film.

CAUTION.—Projectionists who are using old style take-ups should be very careful to set the tension as lightly as is possible without danger of failure to rewind the entire film.

GENERAL INSTRUCTION NO. 24.—The projectionist will wish to know the exact ratio of intermittent speed employed by the various makes of projector, that being an important consideration when his opinion is asked by theatre management which proposes the purchase of new projectors.

Measuring the ratio of intermittent speed is not a very difficult matter, once the process is understood, but it nevertheless requires very careful, accurate work, since a wrong conclusion, by even so much as two or three degrees, would be unfair to the projector or projectors it discriminated against unjustly.

One essential requirement to accurate work is that some method be found by means of which the projectionist may ascertain the **precise** point at which the intermittent sprocket starts and stops. Guess-work will not answer, nor is the sense of sight or of touch sufficiently accurate.

One very effective method which is universally available for ascertaining the exact, precise point at which the intermittent sprocket starts and stops, is as follows: secure a light, flat, straight strip of spring steel. A corset steel will answer very well indeed. It should be not less than six inches in length, and may be longer, though added length is no advantage.

Place one end of this strip of metal against one of the intermittent sprocket teeth when the sprocket is "on the lock," in such manner that when the sprocket starts to move the tooth will press against it. Place the other end against any convenient, immovable object, in such manner that the spring will be under slight tension—bowed slightly. See Fig. 230a.

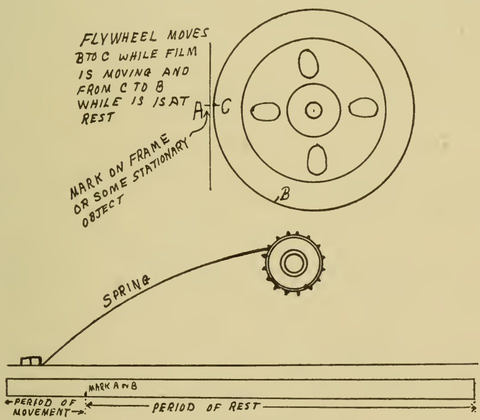


Figure 230a

Under this condition it is readily seen that when the sprocket moves, the spring will be bowed up, hence the movement of the spring will be instantly visible, either to sight or touch, and the precise instant the sprocket starts to move is thus disclosed.

Having the spring in place, move the flywheel slowly, in the direction it normally runs, until the spring starts to bow up. Then rock the wheel backward and forward until the

precise point at which the string starts to move is determined.

Exactly the same process, in reverse, may be employed to find the point at which the sprocket comes to rest. Move the flywheel until the sprocket is almost at rest, and again place the spring against one of the teeth of the sprocket. It will, of course, be bowed a bit less than in the former case, since the sprocket tooth is not yet fully advanced to the lock position. Now move the wheel until the sprocket comes to rest, the exact point being that at which the spring ceases to move.

To measure the intermittent ratio we must first understand that the flywheel of a professional projector makes exactly one complete revolution to each complete picture cycle. In other words, from the time the intermittent sprocket starts to move until it starts to move the next time, the flywheel has made precisely one complete revolution.

It therefore follows that since the edge of the face of the flywheel is a circle, and since there are 360 degrees in every circle, if we can measure, in degrees, the exact distance the

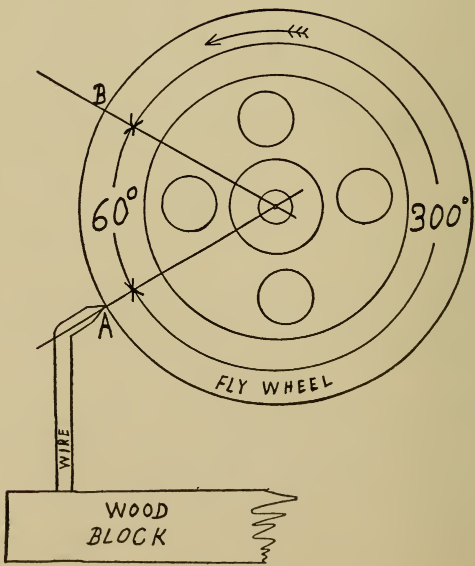


Figure 230b

edge of the face of the flywheel has moved while the intermittent sprocket is in motion, we will then have the number of degrees that edge has moved while the sprocket is moving, and since there are 360 degrees in the complete circle, that number of degrees subtracted from the total of 360 gives us the number of degrees the intermittent sprocket is at rest, and by comparing the two we have the ratio of the time the intermittent sprocke is in movement to the time it is at rest.

TO MEASURE THE RATIO.—In order to measure the ratio of movement, we first must have a locating mark on some stationary object, such as the projector mechanism frame, right close to the edge of the rim of the flywheel, and since this is not possible with all projectors, I would suggest the attaching of a board or block of wood to the side of the mechanism table, by wiring or any other convenient method which will insure its immovability.

In the side or top of this board, or block of wood, bore a hole just large enough to permit of a stiff piece of wire of suitable length, filed to a sharp point at one end, being driven into it tightly. To do this grasp the wire firmly about an inch from its blunt end with a pair of pliers, and drive the wire into the hole by hammering on the side of the pliers beside the wire.

When you have the wire firmly seated in the wood, bend it until its pointed end is as close as possible, without actual contact, to the rim, or edge of the flywheel. This is shown in the drawing, figure 230b.

Presuming the flywheel in figure 230b to move in the direction of the arrow, and that point A of the flywheel to be exactly opposite the point of the wire when the intermittent sprocket starts to move, we make a scratch mark on the rim of the wheel. This scratch mark will, you will, of course, understand, represent the point at which the intermittent sprocket starts to move.

We now move the flywheel slowly, in the direction of the arrow, until, by means of our readjusted flat spring against the sprocket tooth, we find the exact point at which the intermittent sprocket ceases to move. We then make another scratch mark on the face of the wheel, exactly opposite the point of the wire, which is point B, figure 230b.

We now have only to measure the number of degrees between scratch marks A and B to know the number of degrees through which the intermittent sprocket, hence the film itself, is in movement, and to subtract that number of degrees from 360 to know the exact ratio of movement to rest.

If, however, we place marks A and B directly on the wheel itself, it will be difficult to measure the number of degrees between them accurately, hence we suggest the following plan.

There are two methods for taking the record, either one of which is excellent, but the first, while the best, in that no protractor is necessary for the final measurement, is difficult of application on the Simplex, because of the proximity of the face of the flywheel and mechanism casing.

Cut a strip of paper about half an inch wide and long enough to go around the circumference of the flywheel, with half an inch to spare. Place this strip around the face of the wheel, put a dab of paste on the overlapping end and press it down, holding it until it sets and holds the paper band in place.

Now, proceeding as before set forth, locate points A and B, figure 230b, placing the marks on the paper ,instead of on the wheel, though it might be well to add the marks on the wheel also, since you then will have a permanent record on the wheel itself.

Having made the marks on the paper band, draw a sharp knife blade across, exactly at one of the marks—either one —severing the paper, whereupon you will have a strip of paper, on which is a mark, much nearer one end than the other. The short end represents the movement of the intermittent sprocket; the long end its period of rest.

You may now transpose these two distances into ratios of movement to rest by either one of two or three methods, one of which is as follows: First, measure the exact total length of the paper, in inches. Multiply this by 1,000 to reduce the measurement to thousandths of an inch. Divide this result by 360, the number of degrees in a circle, and you have, as a result, the width of one degree of a circle the diameter of your flywheel, in thousandths of an inch.

Next measure the **exact** length of the shorter distance of the mark from the end of the paper and multiply this result by 1,000 to reduce it to thousandths of an inch, whereupon you have only to divide this last result by the width of one degree, in thousandths of an inch, to ascertain the number of degrees during which the film moves in your projector, and the subtraction of the final result from 360 will give you the period of rest, in degrees, as well. We would, however, suggest the advisability of also reducing the longer end of the paper to degrees, so that by adding the two together you may check against any possible error. The two should, of course, total 360 except for a very slight error due to discarding fractions if that is done.

Suppose, for instance, your flywheel measures 10.99 inches in circumference. 10.99 x 1,000 = 10,990, and 10,990 ÷ 360 (degrees in a circle) = 30.5277777 plus, which is where the importance of reducing the measurements to thousandths of an inch comes in, since with such an infinitesimal measurement as the thousandth of an inch, in a matter of this kind we may discard all but 30.5, since it will affect the final result but slightly, though you may use 30.52 if you wish for high accuracy, or even as many of the sevens as you care to.

We now have the width of one degree in thousandths of an inch, and the measurement of the period of movement of the intermittent sprocket and film in thousandths of an inch, therefore the measurement divided by the width of one degree gives the number of degrees of the movement, and the sub-

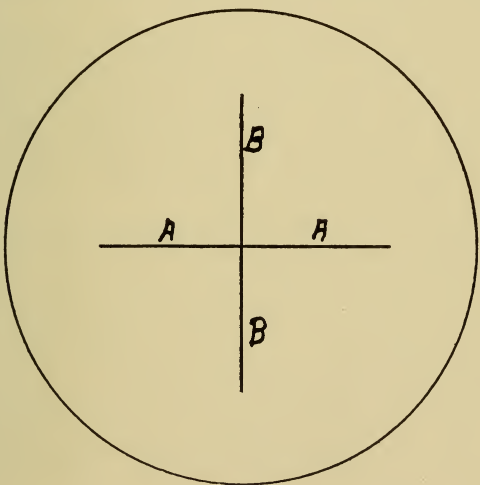


Figure 230c

traction of that result from 360 gives the degree in the period of rest of the sprocket, or you may, as suggested, also reduce that measurement to degrees, and thus check against possible error.

Note:—There probably will be a slight error, due to discarding fractions, but it should only total the fraction of 1/1000 of an inch.

Another, less accurate method, is to measure the distance from the mark to each end of the paper, and see how many times the shorter is contained into the longer, which tells you how the period of rest compares to the period of movement. It may be "five to one," "six to one," etc. Still another method is to set a carpenter's compass to cover the distance from the mark to the end of the paper on the shorter end, and then "step" it along the longer end, which will give you the number of times longer one is than the other. But, after all, the degree method is the only right way.

The other paper method is to cut a circle of paper the diameter of the flywheel, and on it, **before** cutting out the center, while the compass center mark still is there, lay out two lines across the paper, at right angles to each other. These are lines A A and B B, figure 230c. Their purpose will be made clear presently.

Now cut out the center of the paper, if it is necessary, on account of the end of the shaft or flywheel hub protruding beyond the plane of the rim of the wheel, thus preventing the paper from lying flat on the face of the rim of the wheel. Next attach the paper (which must be light cardboard or heavy, tough writing paper) to the rim of the wheel by means of a few drops of paste or shellac, so that it lies perfectly flat against the rim of the wheel.

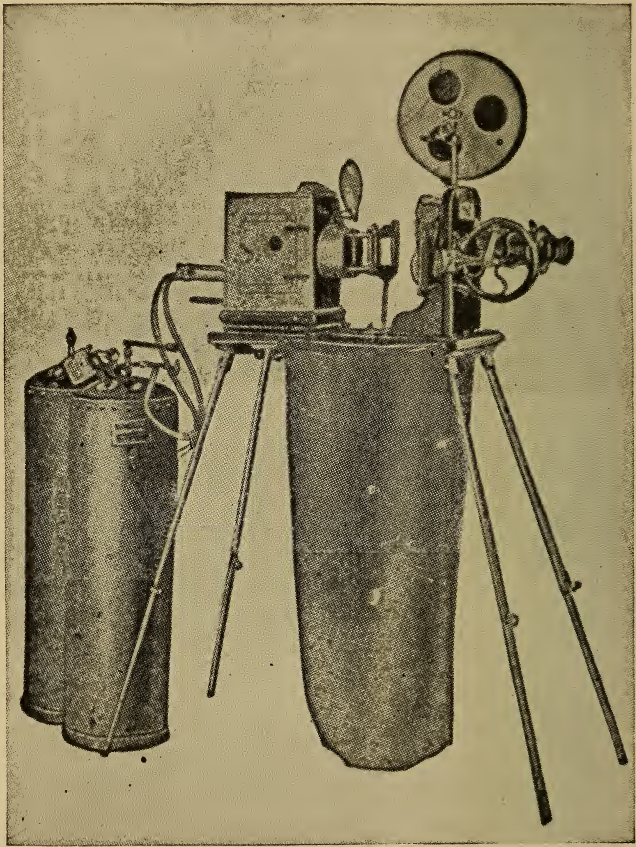
Now locate points A and B, figure 230b, of sprocket movement, as before described, making marks A B, figure 230b, on the edge of the paper disc.

Remove the disc from the wheel, attach it to a clean sheet of writing paper by means of two or three small drops of paste, and, using lines A A and B B, locate their crossing point, which will be the center of the disc.

Now you need a "protractor," which is a half circle of brass, with a center mark and the degrees of half a circle marked on its rim. You may secure one for a small price at any store which deals in draughtsmen's supplies. Usually stationery stores have them.

Lay the protractor with its center mark **exactly** at the center of the disc, and you have but to read the number of degrees between marks A B, figure 230b, to know the number of degrees during which the sprocket, hence the film, is in movement, and that subtracted from 360 gives the degrees in its period of non-movement, or rest.

Note:—If the protractor is too large or too small to fit the circumference of the wheel (as it probably will be) you may measure between lines A B, figure 230b, at any distance from their crossing point, extending them beyond the circle if necessary. The results will be just as accurate as though the protractor were of a radius to fit the circumference of the wheel itself.



Early Model Projector

Note the bag for catching the film.

The Power's Projector

THE Power's projector is now only made in one model for use in North America. That model is the Power's 6B Improved Model, which may be had with either of the following equipments:

The 6B ordinary arc lamp and lamphouse.
The Type E lamphouse and ordinary arc lamp.
The high intensity lamp and lamphouse.
The Powerlite reflector arc lamp and lamphouse.
The incandescent lamp and lamphouse.

In addition the 6A model is made for the export trade, which includes South America, and Central America and Mexico in North America.

The Type E lamphouse is substantially constructed, large and well ventilated. In the right hand back corner is a small incandescent lamp, so arranged that it lights when the lamphouse door is opened, and is switched off when the door is closed.

The condenser mount used with the Type E lamphouse is illustrated in figure 234. Its lenses are carried in a metal holder which is calculated to equalize the expansion of the thin edge and thick center of the lens, and thus reduce breakage. The lamp rack-bars are three-quarters of an inch square. The bearing through which they slide is 2¼ inches long. The surfaces which grip the carbons are 1¼ inches long, of cast iron, dull nickeled. The carbon clamp screws are 5/16 inch in diameter; the leverage for clamping the carbons is ample.

USE GRAPHITE.—The carbon clamp screws and other working parts of the lamp must be kept lubricated with powdered graphite. A dry, unlubricated carbon clamp screw is an abomination and a nuisance. The construction of the lamp, as a whole, is rigid and good. On the front of the bearing carrying the rack bars is a heat shield of asbestos. The lamp has all the necessary, usual adjustments. The dowser is inside. It has two handles so that it may be operated from either side of the projector. These handles are at A, Fig. 234, which figure shows the condenser holder tipped down to get at the lenses. When tipped back up it is locked into place

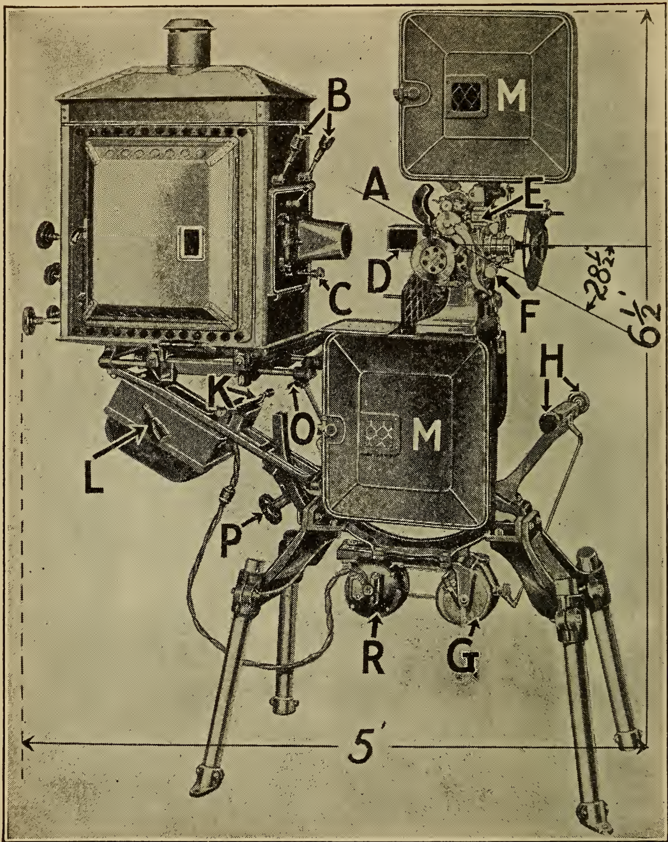


Figure 231. Power's 6B Type E Projector

A—Maximum possible angle projector may be set which is 28½ degrees. B—Double dowser control handles. C—Condenser spacing knob. D—Double ruby glass eye-shield. E—Film footage counter. F—Double refocusing knobs. G—Governor type speed control. H—Double speed control knobs. K—Double motor switch handles. L—Double arc switch handles. M—Square round cornered magazines—take 1,000 or 2,000 ft. reels. O—Hand reel for angular adjustment. P—Hand reel for locking angular adjustment. R—Motor.

NOTE:—At extreme possible angle (28½ degrees) the total height of projector is increased to 6 ft. 9½ inches from floor to top of lamphouse chimney and total front to back length is increased to 4 ft. 10 inches. Outlet for arc lamp circuit should be 4 ft. from wall plus whatever distance bottom of front legs will be from wall.

by handle B. C, Fig. 234, is the screw by means of which the distance between the collector and converging lenses is altered.

INSTRUCTIONS FOR CARE AND ADJUSTMENT OF POWER'S PROJECTOR MECHANISMS.—While at first glance these instructions may seem complicated, they are in fact very simple and quite easily applied. In what follows it is intended to provide all necessary instruction for anything the projectionist may be called upon to do in connection with Power's projector mechanisms and speed controls and we have tried to make the instructions so plain that even the uninitiated may follow them without much trouble.

The Power's mechanism are of the "open" type, which means that there is no inclosing casing. The projector may, by a very simple arrangement, be set at varying heights from the floor. It may be tilted to any angle within the limits of practical projection, either up or down.

In referring to these instructions the numbers indicate the illustration in which they occur and the particular part in the illustration, thus: 659, P. 2, indicates the part numbered 659 in plate 2, which in this case is the intermittent sprocket idler roller bracket.

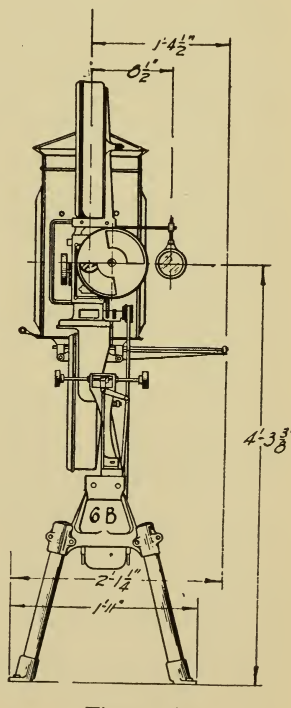


Figure 232.

CARE AND ADJUSTMENT OF POWERS SIX B PROJECTOR — LUBRICATION. — The mechanism and all moving parts must be kept well lubricated, but the projectionist should remember that over-lubrication does no good, and may do much harm. **SEE GENERAL INSTRUCTION NO. 1, P. 626 AND STUDY IT WELL.** The intermittent oil well should be kept filled to proper level, but if the casing cover is tight, and there is no leakage around the bearings, once a week should be sufficient. REMOVE ALL OIL FROM INTERMITTENT OIL WELL ON THE FIRST DAY OF EACH MONTH, and fill with fresh oil. This will add very appreciably to the life of the intermittent movement.

There are oil holes in sprocket idler rollers. These are not for ornament, but for use. Put one drop of fairly thin oil in each sprocket idler roller oil hole daily, working it into the bearing by moving the roller slightly, WIPING OFF ALL SURPLUS OIL CAREFULLY. This instruction applies to the loop setter roller as well.

There are two holes in the main frame casting for oiling the upper sprocket shaft, and two more for oiling shaft, 622, figure 237. One of these holes is in each side of the main frame.

There are two oil holes in part 624 (governor casing), figure 243. One is in the hub, to oil the shaft; the other at the top of the governor casing cover, No. 624, Figure 243 The latter is to supply oil to friction shoes, 626, figure 243. WARNING: Do not over-oil the friction shoes. If you do the automatic fire shutter will probably be sluggish in rising, and may drop down at a too-low projection speed. Just a wee bit of rather heavy oil, applied occasionally, is sufficient.

There are two oil holes in the main frame casting, one near either end of the crank shaft, 631, figure 239, and two holes in the main frame for supplying oil to one end of shaft 641, figure 239.

On top of the mechanism is a hole marked "OIL." This supplies oil to other end of shaft 641. It is closed by a steel ball, which must be pressed down with snout of oil can when applying oil.

One oil hole is in the main frame casting, directly behind gear 680, figure 237, which is the large gear just back of the fly wheel. This, of course, supplies oil to the shaft carring gear 680. The other end of this shaft is oiled by an oil hole on the inside side of the rotating shutter bracket casting. It is close to the edge of the mechanism name plate. WARNING—DO NOT OVERLOOK THIS OIL HOLE.

There are two oil holes in the rotating shutter bracket, supplying oil to the shutter shaft. One is at either end of the bracket. In the 1923 model, adjustable shutter bracket, there are two additional oil holes in part 545, which must not be overlooked.

OILING MOTOR DRIVE. In the new style, 1923 model, motor attachment, there are a total of five oil holes for supplying oil to the bearings. Two of them are directly behind the belt pulley. The others are located one at each of the other three bearings.

There is an oil hole in the top of connecting link 682, figure 241, supplying oil to the stud on which gear 679, figure 241, is mounted, and one in the main frame casting for oiling the take-up, or lower sprocket shaft. Also there is an oil hole in loopsetter part 766, figure 238, for supplying oil to its spindle.

OIL HOLES IN FRAMING CARRIAGE.—In the framing carriage are the following oil holes: (a) One, directly behind the flywheel, in the bearing next the flywheel pinion, for oiling that end of the cam shaft. (b) Another at the other end of the shaft oils that end. This latter is directly behind the intermittent oil well casing. (c) Immediately beneath it is another for oiling the large eccentric bushing bearing of the intermittent sprocket shaft. NOTE: If you have a solid pin intermittent movement then there is an oil hole at the right end of the intermittent sprocket shaft.

WARNING—Do not neglect oil holes in framing carriage, as they are all very important. Examine them frequently and be sure they are clean and open, if you wish to avoid possible serious trouble.

WARNING.—The manufacturer warns you against using any oil other than that supplied by them, especially in the intermittent movement oil well. We add our warning to theirs. They have experimented and found what oil gives the best results. They have a vital interest in the good performance of the projector, hence it is but reasonable to suppose that they will supply you with the lubricant which is best suited for the use for which it is intended. See general instruction No. 1.

WARNING.—Do NOT use the Powerline oil designed for a solid pin movement for a roller type movement. IF YOU DO YOU MAY RUIN THE MOVEMENT.

The take-up shaft is mounted on ball bearings, which are packed in grease, or vaseline. These bearings require very little attention. Examine the bearings every three months, and put fresh, good grade vaseline in the ball races.

All other necessary instructions on the Powers projector will be found either in the General Instructions, or in what follows.

INSTRUCTION NO. 1—REMOVING MAIN DRIVING GEAR AND SHAFT.—To remove main driving gear 630, P-4, and its shaft 631, P-4 and P-7: First remove crank 632, P-5, and the taper pin 789, P-2, which engages the slot in the hub of the crank. The taper pin 789, P-2, should be driven out from its small end. Having removed the pin, the shaft and gear may be withdrawn, and if desired the gear may be removed from the shaft by driving out the taper pin in its hub.

On mechanism equipped with the adjustable shutter bracket, it will be necessary, before proceeding with instruction No. 1, to remove the spindle B, Fig. 249. This is accomplished by removing nut D which is secured by a set screw, then turning knurled knob A to the left, when facing the gate, until spindle B is free from the split nut C. Spindle B can then be withdrawn from the shutter bracket and gear 630 removed as directed above.

INSTRUCTION NO. 2—TO REMOVE SHAFT 618, P-4, CARRYING GEARS 620 AND 619, P-4.—First follow in-

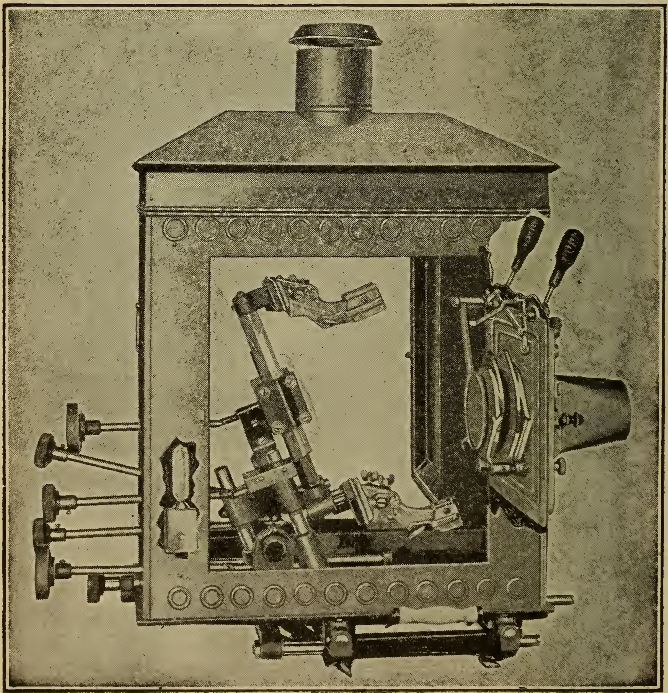


Figure 233.

structions No. 1, then loosen screw 782, P-2, whereupon the shaft and gear may be withdrawn from the gear side.

INSTRUCTION NO. 3—REMOVING AUTOMATIC FIRE SHUTTER GOVERNOR COVER.—To remove the automatic fire shutter governor cover 623, P-2, loosen screw 740,

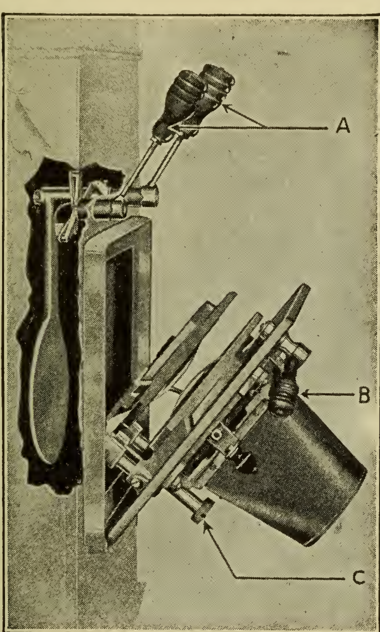


Figure 234.

A—Dowser Handles. B—Lock Handle. C—Screw to change spacing of lenses.

P-2, backing it off considerably, as it is countersunk into the shaft. This releases cover 623 (shown on the left in Plate 9). If the cover does not pull off readily, tap gently on the end of the shaft, at the same time pulling on the cover.

CAUTION.—Do not try to pry the cover off by inserting a screw-driver point between part 623 and 624, P-2. If you do you will probably succeed in ruining your governor.

INSTRUCTION NO. 4—TO REMOVE FRICTION CASING OF AUTOMATIC FIRE SHUTTER 624, P-2.—Follow instructions No. 3, after which remove 798, P-7, whereupon part 624 may be pulled away.

INSTRUCTION NO. 5—TO REMOVE AUTOMATIC SHUTTER LINK 628 AND LEVER 627, P-7.—Follow instructions No. 3 and No. 4, after which the parts may be released by taking out a screw on the reverse side of part 624.

INSTRUCTION NO. 6—ADJUSTING FIRE SHUTTER GOVERNOR.—Should automatic fire shutter 697, P-1, fail to

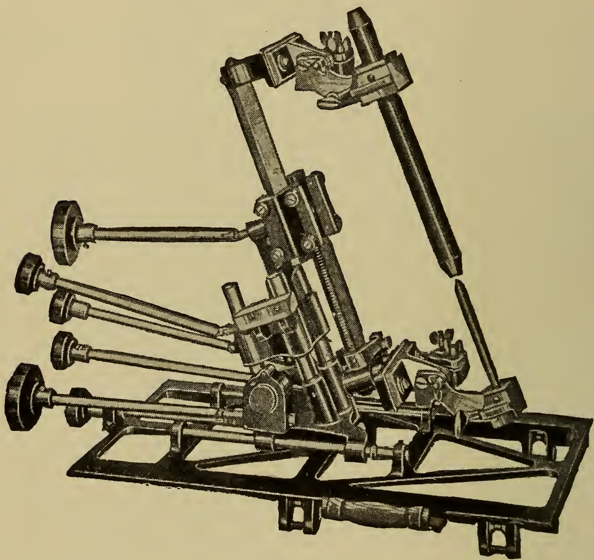


Figure 234-A.

The Power's Late Model Lamp.

drop, examine lever 627 and links 628, P-7, and see that they work freely and are not bent. Usually the binding of these parts is responsible for the sticking of the fire shutter. If this is not found to be the seat of the trouble, remove cover 623, P-2 (see instruction No. 3), and carefully examine springs 717, P-9, also examine the inside edge of friction casing 624 and see if track "Y," Plate 9, is smooth, as it should be, and not scratched or rough. If it is rough or scratched, carefully polish track "Y" by using No. 00 emery cloth.

CAUTION.—Do not use coarse emery cloth or you will only succeed in making matters worse.

Should the automatic fire shutter fail to rise properly, first try injecting a drop of heavy oil in the oil hole on top of 624, P-2. The clutch shoes 625, P-9, act by centrifugal force, which throws out weights 626, P-9, against the action of springs 717, P-9, thus forcing friction shoes 625 against track "Y" on part 624, P-9. The friction thus engendered revolves casing 624 in clock-wise direction, which forces lever 627, P-7, ahead and raises shutter flap 697, P-1. Do not use thin oil on the automatic shutter, as it tends to reduce the friction too much. Use heavy oil sparingly. Should the fire shutter rise too quickly, or should the governor develop undue friction, thus making the mechanism pull hard, it will

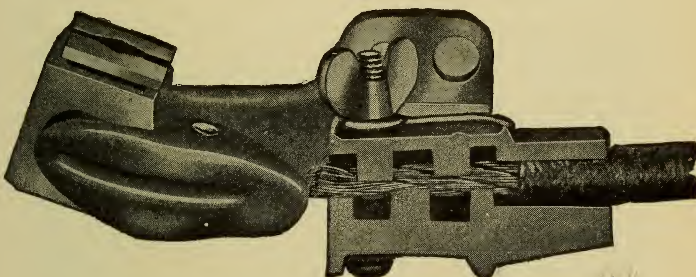


Figure 234-B.

Power's Late Model Arc Lamp with Terminal.

probably be found that springs 717, P-9, have become weakened. This may be remedied by installing new springs or by stretching the old ones. Another possible cause of failure of the fire shutter to act, or to act too slowly, is the binding of the screws at the top or lower end of link 628, P-7. This link must swing perfectly free. In the centre and top of fire shutter flap 697, P-1, is a pin. This pin not only serves to hold the flap to its spindle and prevents its slipping circumferentially, but it also prevents the shutter from rising too high. Therefore, it should not be allowed to become loose and fall out.

INSTRUCTION NO. 7—REMOVING TOP ROLLER BRACKET.—Top roller bracket 612, P-2 and 7, may be removed by taking out stud 710, P-7.

INSTRUCTION NO. 8.—REMOVING TOP SPROCKET IDLER ROLLER 609, P-2.—This may be removed by loosening screw 733, P-2, pulling the shaft out and taking out the collar next the roller. This roller should be repiaced if there is any indication of flat spot on its surface. Before adjusting these rollers, see general instruction No. 12.

INSTRUCTION NO. 9—REMOVING TOP AND LOWER SPROCKETS.—To remove the upper sprocket 617, P-7, first remove the upper apron 629, P-2, by removing the two screws, one at each corner. Then loosen the screw in the centre of the hub of sprocket 617, P-2, pulling the sprocket off the shaft. The lower sprocket 646, P-2, can be removed by loosening the small screw in the centre of hub of sprocket and pulling sprocket off the shaft. See general instruction No. 3 concerning keeping sprockets clean.

If film seems to bear equally on both edges of both sprockets and the aperture plate tracks are not straight

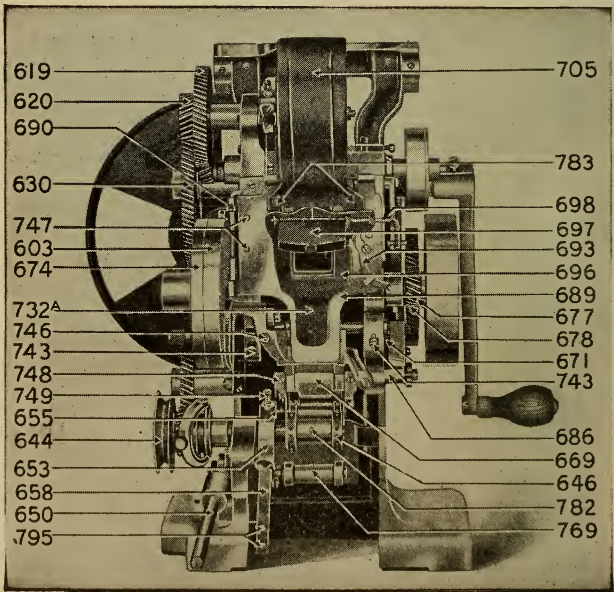


Plate 1, Figure 235.

with film it would indicate aperture plate out of true. Gently drive its top one way or the other, as is required, to square it with the film. The first thing to do, however, before making this test is to be certain your intermittent sprocket shaft is in exact alignment with camshaft.

INSTRUCTION NO. 10—TENSION OF UPPER IDLER ROLLER.—Upper sprocket idler roller 609, P-2, is held to the sprocket by a flat spring, 615. Should this spring at any time become too weak, it may be strengthened by removing the idler roller bracket (see instruction No. 7) and bending the top of the spring outward until the desired tension is obtained.

INSTRUCTION NO. 11—REMOVING THE GATE.—The entire gate, including cooling plate 696, P-1, automatic fire shutter flap 697, P-1, and hinge 690, P-1, may be removed

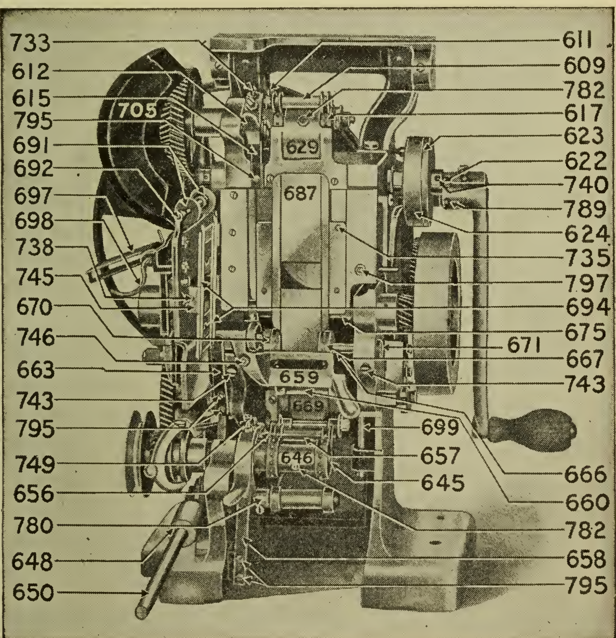


Plate 2, Figure 236.

by taking out screws (three of them) 747, P-1. In replacing the gate, before tightening up screws 747, P-1, be sure that the top gate guide rollers 691, P-3, centre properly with the aperture plate. After replacing the gate project the white light to the screen. If there is a shadow at the top, bottom or side, open the gate. If the opening of the gate removes the shadow, then it means that your gate is not properly centered, and you must loosen hinge screws 747 and move gate until the shadow disappears. Be careful, however, that the gate guide rollers 691, P-3, are kept spaced central with aperture and sprocket, as per Fig. 224.

INSTRUCTION NO. 12—REMOVING AND ADJUSTING TENSION SHOE.—Tension shoe 694, P-2, may be removed by first pulling out the pin in the gate-hinge 690, P-1, after which remove screws 738 (one on either side), P-2. This releases the tension shoe.

INSTRUCTION NO. 13—REMOVING TENSION SPRINGS.—Between the face of the gate and cooling plate

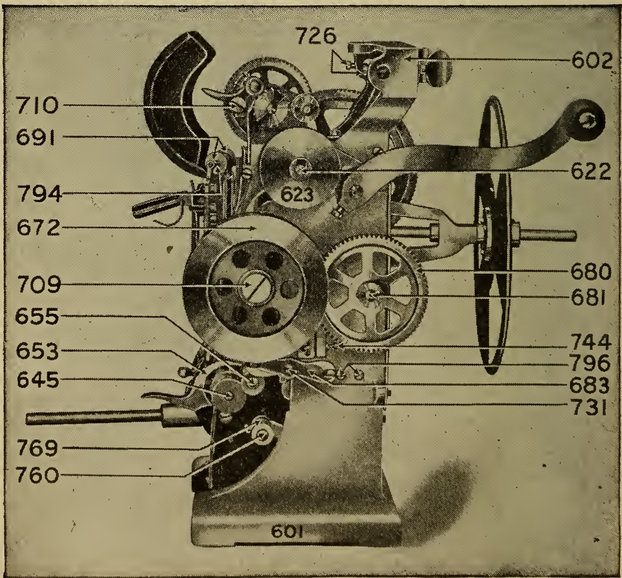


Plate 3, Figure 237.

696, P-1, are the tension springs and the tension spring equalizer. Should it at any time be necessary to remove either of these, take out flat-head screws just above and below the cross-bar joining tension shoe tracks 694, P-2. This will release cooling plate 696, P-1, and expose the parts. In replacing, be sure that the little flat spring which acts on gate latch 693, P-1, rests against the latch and not on top of it.

INSTRUCTION NO. 14—REMOVING COOLING PLATE.—(See instruction No. 13.)

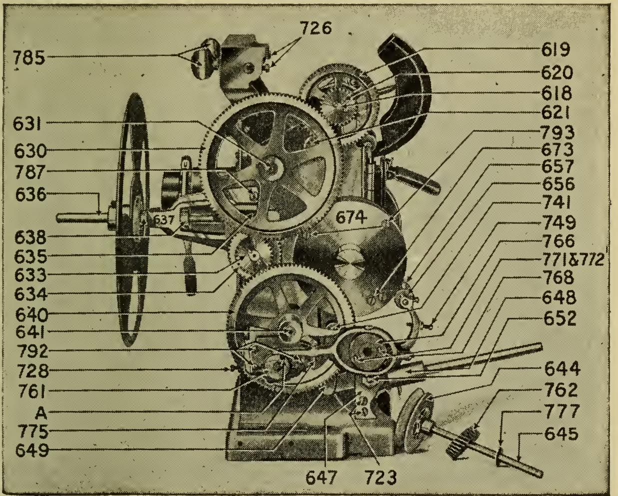


Plate 4, Figure 238.

INSTRUCTION NO. 15—ADJUSTING TENSION.—The pressure of the tension shoes is governed by screw 732A, P-1. Setting this screw inward increases the tension and conversely loosening the screw decreases it. THE TENSION SPRINGS SHOULD BE KEPT SET EXACTLY RIGHT. SEE GENERAL INSTRUCTION NO. 9.

INSTRUCTION NO. 16—APERTURE PLATE.—Aperture plate 687, P-2, may be taken off by removing screws 735 (four of them) and pulling the plate away. In replacing the aperture plate, proceed as follows: Put the plate in place and insert the four screws holding it, tightening them down just enough so that by tapping lightly on the edge of the plate it may be moved either way. Now project the white light to the screen and move the aperture until the upper and lower lines of the light are level on the screen whereupon tighten up the four screws.

CAUTION.—In removing parts of this kind, remember that the screws are small. Do not lay them down anywhere, depending upon luck to find them. Have a cigar box or small receptacle of some kind in which to place all screws, or in lieu of that, replace them in the holes when you take the part away. Then you will know where they are when you want them. A magnetized screw-driver is a fine thing to handle small screws with. See general instruction No. 19.

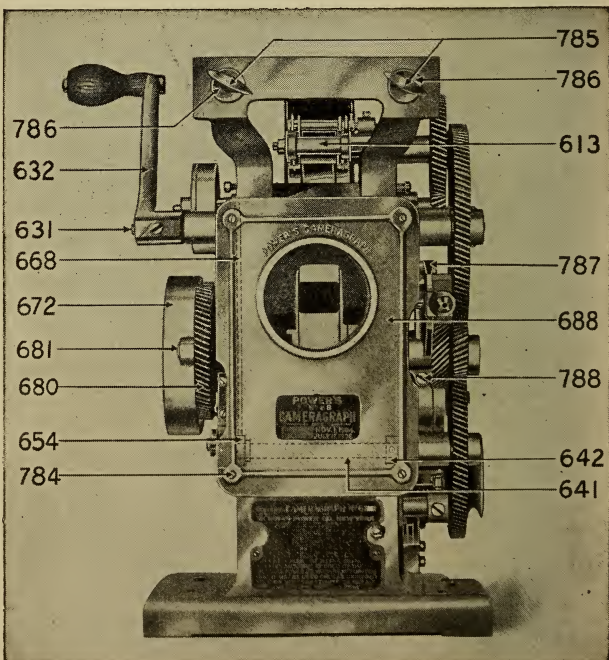


Plate 5, Figure 239.

INSTRUCTION NO. 17—ADJUSTING GATE LATCH SCREW.—The right-hand edge of the face of the gate and its left-hand edge should set an equal distance away from the face of the machine casting, since otherwise the tension shoe will exert greater pressure on one side than will the other. This is regulated by the gate latch screw 797, P-2. This screw should be set at a sufficient distance to bring the entire gate square with the face of the machine casting and the lock nut thereon should then be set up tight to prevent any change in this adjustment.

INSTRUCTION NO. 18—REMOVING INTERMITTENT ROLLER BRACKET.—Roller bracket 659, P-2, may be removed by taking out the screw in its hinge, first, however, having loosened screws 795, P-2, holding the spring 663, P-2. The distance of the idler roller which this bracket carries from the intermittent sprocket may be varied by tightening or loosening screw 746, P-2. See general instruction No. 12.

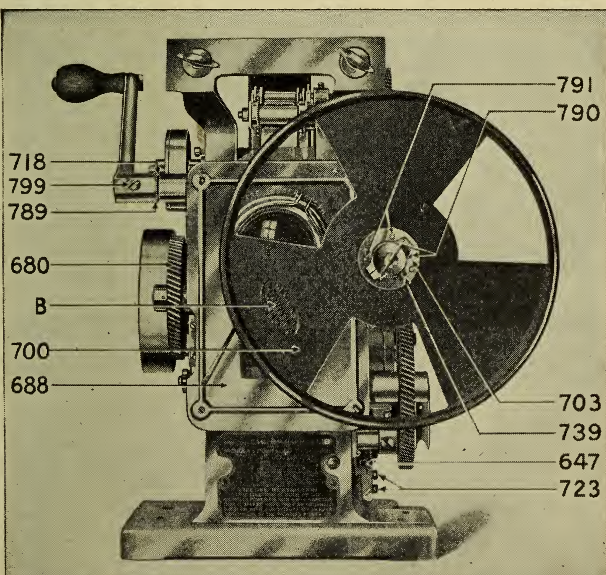


Plate 6, Figure 240.

To vary distance of idlers from sprocket first loosen nut on its outer end, then turn the bracket clear up and the head of the screw will be found underneath. The further this screw is backed out, the further the roller will be from the sprocket, and vice versa. After the proper adjustment is made, be sure to tighten lock nut on screw 746, P-2. The tension of this bracket is governed by flat spring 663, P-2. This may be made greater or less by bending the spring. If it is to be made less, just bend the upper end of the spring down, but be careful and do not bend it too much.

INSTRUCTION NO. 19—REMOVING AND ADJUSTING APRON.—Apron 669, P-1, may be taken off by removing two screws (one on either side) near the roller near its base. The adjustment of this apron is quite important. Should the

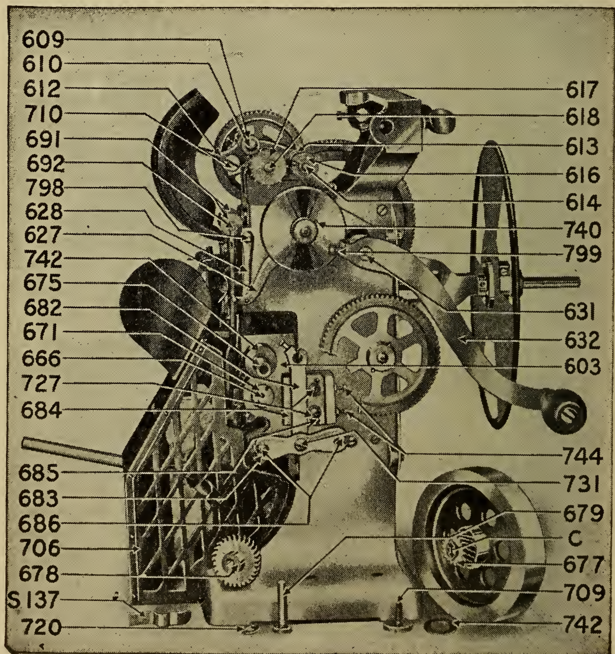


Plate 7, Figure 241.

film make a chattering noise in going through the machine, carefully bend the ears at the lower end of apron 669, P-1, which carry the rollers, ahead slightly, being careful to bend each one the same amount. If this remedies the trouble, well and good. If it helps, but does not remedy it, then try bending it a little more. If it makes it worse, bend the rollers back slightly. You can do no damage by bending these apron ears, provided you keep the rollers square with the sprocket, that is to say, equidistant from the sprocket. To test this, measure from the face of the hub of the roller to opposite teeth on the lower sprocket.

INSTRUCTION NO. 20—REMOVING AND ADJUSTING LOWER SPROCKET IDLER BRACKET.—Lower sprocket idler bracket 653, P-1, may be removed merely by taking out its hinge screw, first, however, loosening screws 795, P-1, holding flat spring 658. The distance of the roller which

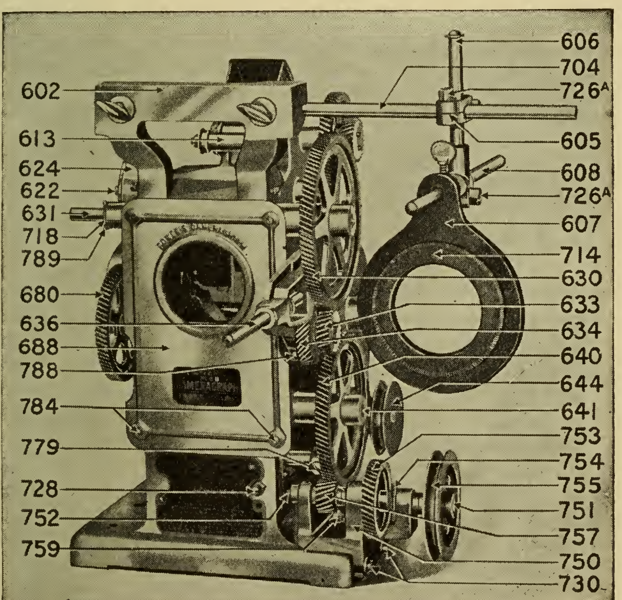


Plate 8, Figure 242.

this bracket carries from the sprocket (see General Instruction No. 12) is determined by the position of the screw 749, P-1. Spring 658, P-1, should supply sufficient tension to this bracket to hold it firmly in place when it is closed down, but this may be overdone. The tension of this bracket should not be sufficient to cause the sprocket teeth to punch through, or even indent the film should it climb the sprocket. This adjustment calls for the exercise of judgment. If it is too tight, damage may and probably will be done to the film.

INSTRUCTION NO. 21—TO REMOVE FLYWHEEL 672, P-3.—Remove screw 709, P-3. If you cannot start this screw with an ordinary screw-driver, grind down the broad end of a file to make a screw-driver for this purpose. Having removed this screw, place the point of the screw-driver right up close against the hub on the opposite side of the wheel, and tap gently until the wheel becomes loose. In replacing the flywheel be sure that groove C in pinion 677, P-7, connects properly with the key on the camshaft. In order to accomplish this, insert the point of a screw-driver between the lugs carrying brackets 659, P-2, and the collar on shaft 675, P-2, and pry gently downward. This will hold the spindle stationary while you twist the wheel until the slot and key come opposite each other. CAUTION: Between pinion 677, P-7, and the hub of the casting it fits up against is a thin steel washer, 742, P-7. This washer fits on the larger diameter of the shaft and you must be careful that it is precisely in place before the wheel is forced on, or you will have trouble. When the wheel is in place, tighten up screw 709, P-3, tight.

INSTRUCTION NO. 22—REMOVING TOGGLE GEAR.—To remove toggle gear 678, P-1 and 7, follow instructions No. 21, then loosen the screw in the upper end of connecting link 682, P-7, whereupon the gear and spindle may be pulled out. The adjustment of this gear is a very important matter. The gear must be exactly centered between flywheel and pinion 677, P-1 and 7, and gear 680, P-3. The toggle gear is carried by connecting link 682, P-7, and its position with relation to the gears on either side of it is determined by the position of the casting 684, P-7. Should a grind develop in this gear, first having made sure that connecting link 682, P-7, is held snugly in its ways by casting 685, P-7, using a soft metal punch, tap lightly first one way and then the other against casting 684, P-7, the idea being to slip the casting slightly against the pressure of the screws which hold it.

The casting cannot be moved much, but sometimes enou... movement may be accomplished to remove or reduce a grind.

INSTRUCTION NO. 23—ADJUSTING CONNECTING LINK.—Connecting link 682, P-7, plays an important part, and must be kept tight in its ways. If by shaking horizontal bar 683, P-7, you are able to move connecting link 682, in its ways, then it is too loose and may be tightened as follows: First loosen screws 727, P-7, then release lock nuts on 744, P-7, tighten screws 744 a trifle, next retighten screws 727, P-7, and try the framing lever. If it is still too loose, then you can give them a little bit more, but be careful and do not get them too tight or your framing carriage will bind. In making this adjustment do not set screws 744 in so much that the connecting link fits snugly while screws 727 are loose, because if you do, when you tighten screws 727 the whole thing will be clamped solid. Be sure that screws 727 and the lock nuts on screws 744 are set tight.

INSTRUCTION NO. 24—REMOVING LOWER SPROCKET SHAFT.—To remove lower sprocket shaft, loosen screw 782, P-1, and pull the shaft out to the left.

INSTRUCTION NO. 25—REMOVING LARGE IDLER GEAR.—To remove large idler gear 640, P-4 and 8, remove the mechanism from the stand, then remove motor attachment, if projector is motor operated, by removing screws 730 and 759, P-8, when motor attachment will come away from the mechanism. Turn it bottom side up and, looking, you will see the shaft which holds this gear, and on it, resting against the mechanism casting, a brass collar, the stock number of which is 642, P-5. Move the flywheel until the set screw in this collar comes into view. Loosen the set screw and you may then pull the gear and its shaft out.

INSTRUCTION NO. 26—REMOVING THE LOOP SETTER.—Loop setter fork 768, P-4, may be removed by first following Instructions No. 24 and 25. Then remove stud 775, P-4, which will release the fork and clutch 766, P-4. Loop setter cam 761, P-4, is removed by following Instructions 23, 24 and 25, loosening the two large screws in its face and pulling it off the shaft. Should it be necessary to remove the loop setter arm, carrying roller, 769, P-3, or the spring which provides tension therefor, first follow Instructions 24 and 25, then loosen screws 792 (three of them), P-4, when the loop setter arm may be pulled out though the hole in the mechanism casting. The replacement of these parts is merely a reversal of the process of their removal, but in replacing them be sure that all screws, particularly screws 792 and the screws in cam 761, be set up tight. In replacing the loop setter, be careful that roller 769, P-3, lines with the lower sprocket, or, in other words, that the roller sets perfectly "square with the film," since otherwise when the loop setter acts, the pull would be all on one side of the film and this might, and probably would, cause trouble.

INSTRUCTION NO. 27—ADJUSTING LOOP SETTER SCREW, 728, P-4 is for the purpose of adjusting or regulating the throw of the loop setter arm and roller 769, P-3. This screw should be so adjusted that roller 769, P-3, rests about half-way between the lower sprocket and the top of the front cross bar in the base of the mechanism.

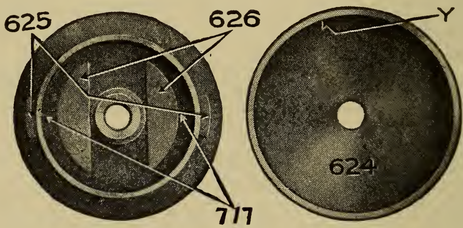


Plate G, Figure 243.

INSTRUCTION NO. 28—THE SHUTTER BRACKET.— When a new machine is received, shutter bracket 637, P-4, will be folded down against the mechanism, and shutter blade 700, P-6, will be tied to the mechanism. Raise shutter bracket 637, P-4, up until it is in a horizontal position, as shown in plate 4, and screw 787, P-4, has engaged the hook on the upper part of the bracket, first having backed screw 787 out sufficiently so that the hook will pass in behind its head. Now, having raised the bracket clear up, tighten screw 787, P-4 and 5, tight, and then tighten screw 788, P-5, up tight. CAUTION: Do not tighten screw 788 until you have tightened screw 787, because if you do it will probably cause the shutter spindle to bind in the bracket.

INSTRUCTION NO. 28½—TO REMOVE THE SHUTTER BRACKET.—The entire shutter bracket 637, P-4, may be removed from the machine by first following Instructions No. 1, 24 and 25, and loosening screws 787 and 788, P-5. Then drive out the taper pin in the hub of gear 680, P-3, and drive out shaft 681, P-3, carrying with it on the opposite end gears 633 and 634, P-4. To drive out shaft 681, use a brass punch slightly smaller in diameter than the shaft.

NOTICE.—On mechanisms equipped with the adjustable shutter bracket, it will be necessary, before proceeding, to remove the shutter bracket, to first remove spindle B, Fig. 249. To do this proceed as follows: Remove nut D, Fig. 249, which is secured by a set screw, which must first be loosened. Next turn knurled knob A, Fig. 249, to the left (counter clockwise) as you face the screen, or as you face the mechanism gate if the projector is off the stand, until it is disengaged from split nut C. Spindle B may then be withdrawn from the bracket and the bracket may be removed as above directed.

INSTRUCTION NO. 29—REMOVING SHAFT 681, P-3, AND GEARS 633 AND 634, P-4—See Instruction No. 28.

INSTRUCTION NO. 30—INSTALLING SHUTTER DRIVING GEARS, 633, 634 AND 635, P-4.—DO NOT ATTEMPT IT. If these gears need replacing, it will be necessary to send the mechanism to the factory or to a thoroughly competent repair man. The same applies to shutter shaft 636, P-4. It would hardly be possible for the projectionist to replace gears 633, 634 or 635, or to put in a new revolving shutter shaft, and get the parts adjusted so they would run smoothly.

INSTRUCTION NO. 31—REMOVING SHUTTER FROM HUB.—In P-6, we see a three-blade shutter. This blade may be changed to a two-blade, using the same hub, by loosening screw 739, P-6, pulling the shutter off its shaft and removing the three screws 791, P-6, in the back of its hub. This releases the shutter blade, which may then be changed to another one of different design if desired.

INSTRUCTION NO. 32—SETTING THE SHUTTER.—On projectors not equipped with adjustable shutter bracket as per Fig. 249, shutter 700, P-6, may be set by loosening screw 790, P-6, in hub, which will allow the outer hub to revolve on the inner, and enable the projectionist to set the shutter in any desired position. When a new mechanism is received the revolving shutter shaft will be folded down. Raise it up, loosening screw 787, P-5, until it will enter slot in shutter bracket. Raise shaft as far as it will go and set up screw 787, tight. Next tighten screw 788, P-5, which also holds bracket. Be sure you tighten both these screws after raising shaft into place. Next place shutter on shaft with hub out as shown in P-3, with screw 739, P-6, in V groove in shaft.

Should travel ghost (streaks up and down from letters of titles, or flashes of white up and down from white object in pictures) develop at any time, it may be eliminated by resetting the shutter. Loosen one of the screws 790 and slack off on the other one until shutter can be slipped by applying some pressure. If streaks are up hold flywheel stationary and revolve the top of the shutter away from you slightly, and, with a title having white letters on an opaque background, try it. If the streaks are down, pull top of shutter towards you. Keep slipping shutter slightly and trying until streaks disappear. Then tighten up screws 790. When travel ghost develops, first be sure screw 739, P-6, is set up tight. To set a new shutter, proceed as follows: Place shutter on shaft as shown in P-6, with hub towards end of shaft. Set screw 739, P-6, in groove and tighten it. Loosen screws 790, P-6, so that shutter revolves freely on inner hub. Open gate and turn flywheel forward until intermittent sprocket is just at point of moving. Set shutter as shown in P-6 and tighten one of 790 slightly. Then proceed as directed for travel ghost. For very short focal length lenses the Nicholas Power Company will supply a special shutter on application. Their two-blade shutter should always be used on 60-cycle A. C. The blade with stamp B, P-6, on it is the master blade, and the only one to be considered at all in setting the shutter.

Travel ghost may be caused by (a) screw 739, P-6, being loose. (b) Collars 638, P-4, not set up snugly against bearing, thus allowing end play in shutter shaft. (c) Gear 680, P-3, loose on its shaft. (d) Gear 633, P-4, loose on its shaft. (e) Badly worn gears. Any one of these things, or all combined, may cause travel ghost. Screws clamping shutter blade in flanges of hub being loose might also be responsible for it.

TRAVEL GHOST may also be caused by master blade being too narrow, in which case it may be removed by moving the shutter to a position where it will cut the light beam at a point where it has less diameter, if there is such a point, or by making the blade itself wider.

NOTICE.—On mechanisms equipped with adjustable shutter bracket Knob A-figure 249 should be turned until the Fork D is located centrally between bearings C and E. Having done this you may make the roughly correct adjustment of the shutter as before directed, completing the final adjustment by turning Knob A, figure 249 in the required direction after the projector is running.

INSTRUCTION NO. 33—REMOVING OIL CASING COVER.—To remove oil casing cover 674, P-4, follow Instructions No. 24 and 25. Next remove screws 793 (three of them), P-4, and tap lightly on the hub of the cover to break the shellac joint.

In placing this cover back, scrape the edges lightly, but be sure and get them perfectly clean. Then smear edge of the cover (not casing edge, but the cover edge only) with thick shellac and clamp the cover in place. It is better if the shellac dries a little before you put on the cover, but don't let it dry too much. CAUTION: DO NOT PUT ON TOO MUCH SHELLAC. If you do it will squeeze out into the interior of the oil casing and get between the pins and the cam, and may do serious injury to the intermittent movement. Instances have been known where an excess of shellac has broken the geneva pins.

On Power's mechanisms manufactured since the latter part of 1923 the intermittent casing cover has been made with a recess into which an oil seal packing ring or gasket has been placed. This gasket eliminates the use of shellac in sealing the intermittent casing. If, however, the gasket should be damaged when removing the cover a new gasket should always be inserted.

INSTRUCTION NO. 34—REMOVING CAMSHAFT AND CAM.—First follow Instructions Nos. 21, 24, 25 and 33. Then loosen the two screws 743, P-2, in bushings 670 and 671, P-2. Then loosen the two set screws in the collar on shaft 675, P-2, just above arrow head, 670, P-2, move the collar over to the right, and, with a small fine file smooth off the burrs caused by the set screws. The shaft and cam may now be pulled up to the left. CAUTION: In replacing the shaft, do not forget to put collar on and tighten the two screws 743, P-2.

INSTRUCTION NO. 35—REMOVING INTERMITTENT SPROCKET, ITS SHAFT AND PIN CROSS AS A UNIT.—To remove the intermittent sprocket, its shaft and the pin cross as a unit, first follow Instructions Nos. 19, 21, 24, 25, 33 and 34. Next loosen screws 743, P-2, and the entire unit, including the large bushing in which the shaft runs, may be pulled out through the oil well.

INSTRUCTION NO. 36—ALIGNING SPROCKETS.—It is of the utmost importance that upper sprocket 617, P-2, intermittent sprocket 667, P-2, and lower sprocket 646, P-2, and aperture plate be all kept exactly in line. The alignment of intermittent sprocket, upper sprocket and aperture plate may be tested by placing a short strip of film (don't use worn film for this purpose) in the mechanism with the gate open. Place it on the intermittent sprocket and close idler bracket. Engage sprocket holes on film with teeth of upper sprocket and turn flywheel backward until film is stretched tightly, being careful that teeth are in centre, sidewise of sprocket holes. If sprockets and aperture are not in perfect alignment the fact is readily detected by the film edge not being in line with tracks on aperture plate, or aperture not being central in film.

If film seems to bear equally on both edges of both sprockets and the aperture tracks are not straight with film, it would indicate aperture plate out of true. Gently drive its top one way or the other, as is required, to square it with the film. The first thing to do, however, before making the test is to be certain your intermittent sprocket shaft 666, P-2, is in exact alignment with camshaft 675, P-2.

INSTRUCTION NO. 37—REMOVING THE FRAMING CARRIAGE.—To remove the entire framing carriage of the mechanism, first remove the aperture plate (see Instruction No. 16) and the gate (see Instruction No. 11). Next remove the screw 741, P-4, turn the machine around and, looking in through the lens hole, you will see two perpendicular rods the top ends of which are held in cast lugs. Loosen the set screws in these lugs and in similar lugs at their lower ends, and pull these perpendicular rods out from below. Next remove horizontal bar 683, P-3, by taking out screw 731, P-3. The carriage may then be taken from the machine.

INSTRUCTION NO. 38—LUBRICATING GEARS.—See "Gear Lubrication," under General Instruction No. 1.

INSTRUCTION NO. 39—TO THREAD THE MECHANISM.—See General Instruction No. 20, with the notation that if there be a loop setter the film must pass under its roller, A, P. 10, and should just clear it when the lower loop is at its shortest.

INSTRUCTION NO. 40—THE LOOP SETTER.—The Powers loop setter, illustrated in Plate 10, is a simple device which operates well. It automatically re-sets or re-forms the lower loop whenever it is "lost" by reason of any one of the several causes which may be responsible for this very annoying thing. Plate 10 shows the film forming the lower loop around roller A. When the loop is lost (drawn taut), the roller is necessarily elevated, thus causing a slight rotary motion in cylinder b. A diagonal slot in this cylinder, in contact with a pin fastened to arm C, causes the arm to move outward; but as arm C operates as a lever, with its fulcrum at point D, the other end of the arm at E moves inward, thus disengaging pin F from the driving pulley G. This breaks the connection whereby motion is transmitted to take-up sprocket H, and the sprocket stops revolving. The loop reforms instantly, and roller A is forced back into its original position by coil spring I. Pin F immediately re-engages with driving pulley G, and the take-up sprocket H starts to revolve again as a natural consequence. The whole train of operation is automatic—its results instantaneous.

INSTRUCTION NO. 41—Always wipe edges of aperature before threading.

INSTRUCTION NO. 42—ADJUSTING 6A TAKE-UP TENSION.—The take-up tension is adjusted by setting the collar on pulley end of spindle in or out, thus applying more or less pressure to the spring which holds the two halves of the grooved, split pulley together. Tension is not regulated by the belt, but by the two halves of the pulley rubbing together under more or less friction, according to how much is supplied by the spring. Take off the belt and pull the two halves of the pulley apart a little and you will see how it works. There should be no more tension than barely enough to revolve the reel when it is full. Anything more is very hard on the film and tends to cause loss of the lower film loop. See General Instruction No. 23.

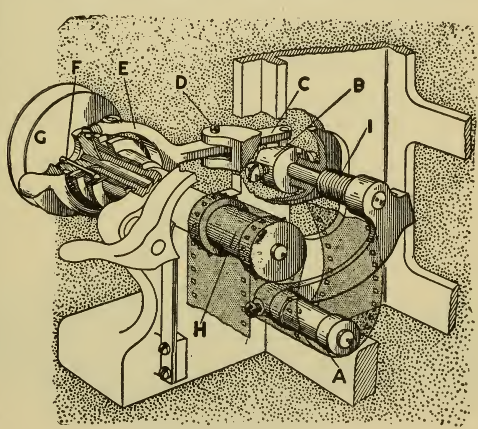


Plate 10, Figure 244.

INSTRUCTION NO. 43—ADJUSTING 6B TAKE-UP TENSION.—The 6B take-up consists primarily of two friction discs, which are held in contact by means of a coil spring. One of these discs is faced with fibre, which assures an excellent frictional contact. The driving disc a, Plate 11, is left free to revolve around take-up spindle b, as an axis. The driven disc c, is fastened to spindle b. By frictional contact, motion is transmitted from disc a, to disc c, and thus spindle b is caused to revolve also. The take-up reel fastens to spindle b at d. The reel is held firmly on the spindle by means of catch e. When the catch is in a horizontal position, it is in exact line with spindle b, thus making it very easy to put the reel on, or take it off the spindle. Spindle b runs in ball bearings f, which eliminate all unnecessary friction in operation.

The friction between discs a and c may be adjusted by increasing or decreasing the tension on spring g. This may be accomplished by simply giving a few turns in either direction to collar h, which is threaded on the end of spindle b. When the desired tension has been secured, the collar may be locked in place by means of set screw i.

INSTRUCTION NO. 44—THE LAMP.—The lamp should not be allowed to become dry from lack of lubrication. It is next to impossible to properly handle the light using a dry lamp. Once a week apply sparingly a little lamp lubricant on all movable parts, such as threaded adjusting gears,

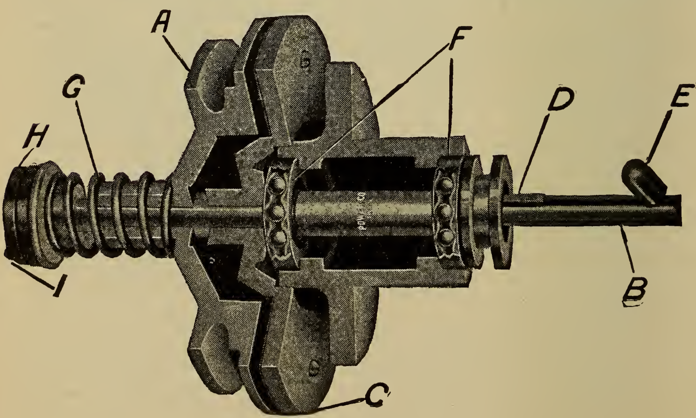


Plate 11, Figure 245.

racks, sleeve rollers, etc. This lamp lubricant is put up in cans by the International Projector Corporation. Be sure and do not use too much of the lubricant, and do not get any on the mica insulation. You will be surprised how much better you can handle the light. Keep metal clean where carbons make contact with it. Scrape and clean thoroughly at least once a week. Dirty carbon contacts induce heating and loss of power and light. Be sure the wires make a good electrical contact with lamp binding post. When terminal lugs become burned, throw them away and put on new ones. It does not pay to use burned lugs. When wires inside lamp house become burned (the life gone out of them) cut away the burned portion. Burned wires cause high resistance and loss. Unless removed, they will eventually burn off entirely, causing vexatious delay.

POWER'S ROLLER PIN INTERMITTENT MOVEMENT —HOW IT WORKS

IN drawings A, B, C, D, Fig. 245, you see principal parts of the Power's Roller Pin Intermittent Movement in four successive stages or cycles of operation. The cam and pin cross are assumed to be revolving in a clockwise direction as indicated by the arrow. The intermittent sprocket is engaged with a short strip of film. The section marked E of this film lying between the two heavy black cross lines represents one frame or picture.

In figure A the four rollers of the pin cross are shown in engagement with the locking ring of the cam, rollers No. 1 and 2 being at the outer circumference and pins Nos. 3 and 4 at the inner circumference of the ring. The ring is free to revolve between the four rollers but cannot impart motion to the pin cross as the rollers are securely locked between the inner and outer surfaces of the locking ring and consequently the pin cross, sprocket and film are at rest and one frame or picture is being projected to the screen while stationary.

In Figure B the end of the locking ring is just passing out from between the four rollers and the diamond of the cam is starting to engage with roller No. 1. As the movement of the diamond progresses the roller and pin on which it revolves is pushed forward and downward, thus imparting a rotary motion to the pin cross spindle and the intermittent sprocket attached to it pulls the film downward. Figure C shows the position of the parts of the intermittent movement near the end of the film movement cycle. Roller No. 1 has almost reached the highest point of the cam diamond, roller No. 2 has started to enter the slot F, roller No. 3 is describing an arc in the space between the ends of the locking ring and

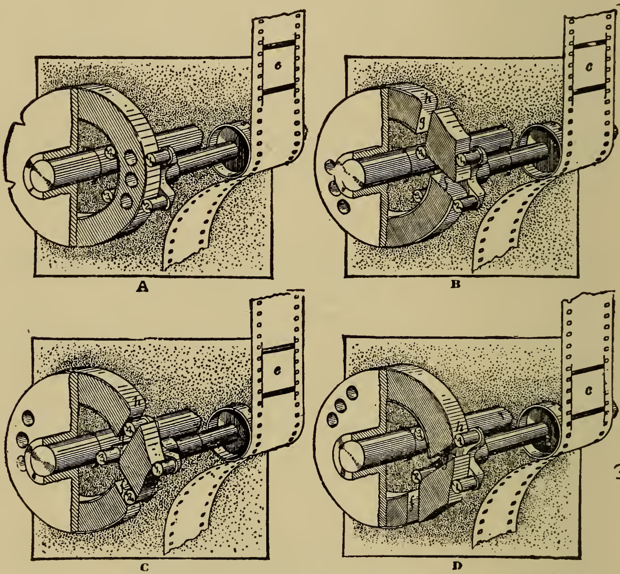


Figure 245.

roller No. 4 is emerging from the slot G. As roller No. 1 passes over the point of the diamond roller No. 4 engages with the curved surface H at the end of the locking ring and the roller is thrown forward and downward until it slides on to the outer surface of the locking ring. Figure D represents the position of the intermittent parts after the film is about to be brought to rest. Roller No. 4 has just reached the outer surface of the locking ring and the four rollers are immediately locked as the locking ring enters the space between them.

In contrast with the position of the rollers shown in figure A rollers No. 1 and 4 are now at the outer circumference and rollers No. 2 and 3 are at the inner circumference of the locking ring and the pin across spindle has made one quarter revolution and pulled the film down a distance equal to the height of one frame or picture. The rollers can only move in the path of a circle. As rollers No. 2 and 4 travel through their respective slots it might seem that they must travel in a straight line. This, however, is not the case. Since the locking ring is revolving the position of the slots constantly change so that their straight lines intersect the circular path of the rollers at successively different points resulting in a rotary motion being imparted to the pin cross spindle.

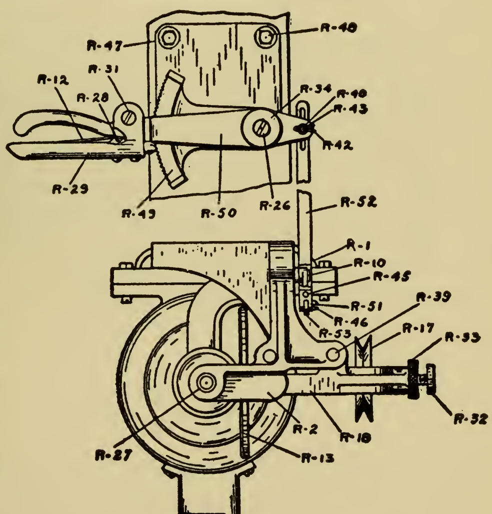


Plate 12, Figure 246.

OLD STYLE POWER'S MOTOR DRIVES.—When using old style Power's motor drives it is important that you have the friction pulley in alignment with disc on motor. When starting show, begin with slow speed and increase until you reach the required projection speed.

When motor drive is not in use, see that friction driving disc R-15, Plate 13, is not bearing on disc R-13, Plate 13. It should be free from contact.

1. Motor should be kept free from dust, and do not allow oil to get into the motor windings.

2. Belt on V pulley should not be too tight.

3. Never put too much pressure on the adjusting screw

R-32, Plate 12, as it flattens the driving disc R-15, Plate 13. If necessary, trim the leather disc just a trifle so that the side first touching the friction disc, when the speed lever is shifted over, is a trifle higher than the other side.

4. Driving disc must be kept free from oil.

5. Grease cups should be kept supplied with motor cup grease and the wicks occasionally trimmed and cleaned.

All Power's projector stands of the later type are drilled to receive Power's speed control. When the projector is received, the speed control parts, as shown in Plates 12, 13 and 14, are assembled, with the exception of the lever R-52,

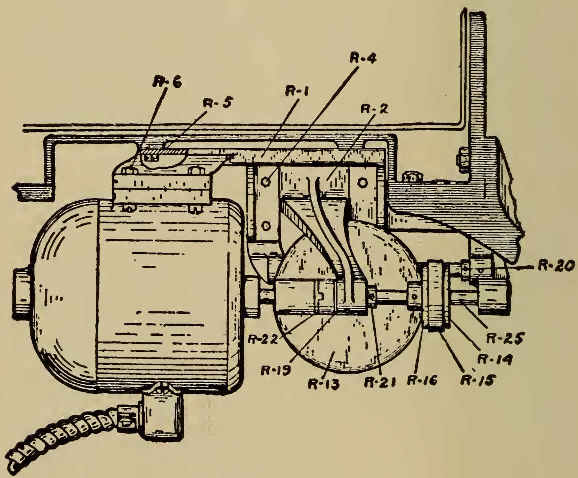


Plate 13, Figure 247.

but the control is not attached to the stand. All that is necessary to attach the control is to place same in the proper position, as shown in Plate P-12 and P-13, with the motor towards the rear end of the projector, and fasten it into place by means of bolts R-5 (four of them) P-13. Be sure that the contacts between the casting and the control are clean and set up bolts R-5 (four of them) tight.

This instruction holds good with both the old style 6A non-adjustable and the new style 6B adjustable stand. It is then necessary to attach the lever control, P-12. If it is the old style 6A non-adjustable stand, this lever and its casting is attached by means of bolts R-47 and R-48, P-12. If it is the new style adjustable stand, then a special bracket is sent. This bracket is attached to the casting by means of two heavy machine screws. Having attached the control lever, all that is necessary to complete the installation is the connecting of lever R-52, P-12, with the end of the control lever at R-42, P-12, and with the bell link R-53, P-12.

NOTE.—All parts except very small screws have the stock number either stamped or cast right into the part—a very excellent arrangement.

All projector stands are drilled to receive the speed con-

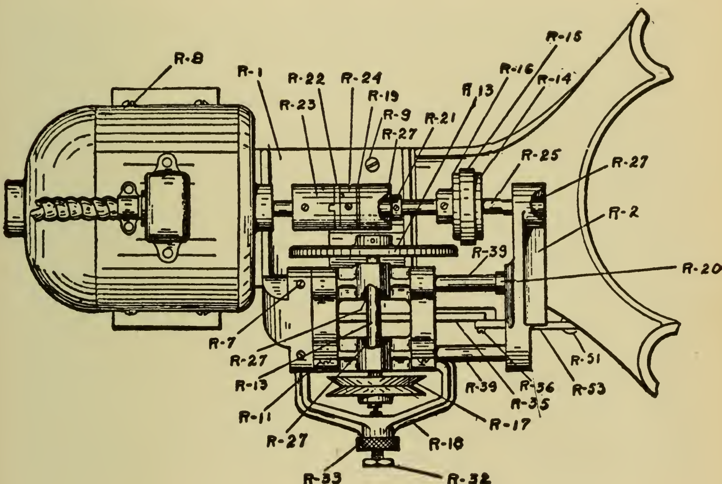


Plate 14, Figure 248.

trol so that you can order same at any time and install as per the foregoing instructions.

INSTRUCTION NO. 1.—The friction material R-15 is leather. Should it at any time develop flat spots or become out of round or eccentric in form, it may be trued by placing the point of a new 10-inch or 12-inch coarse file on rod R-39, P-14 (using the rod merely as a rest) and bearing lightly on top of friction material with motor running.

CAUTION.—In doing this, be very careful to hold the point of the file perfectly flat on the rod, since if you hold it at an

angle you will get the face of the leather ground off on a slant and it will then not fit the disc wheel squarely.

INSTRUCTION NO. 2.—New friction material may be ordered from the Nicholas Power Company, Incorporated, at any time. The old material may be removed by loosening the set screw in the hub R-16, P-14, and in set collar R-21, P-14, and in R-24, P-14. Having done this, R-25, P-14, may be pulled out to the right, thus releasing the friction wheel. You can then take out the old friction material by removing the screws in the face of R-16, P-14. The process of reassembling is the reversal of the process of dis-assembling, but

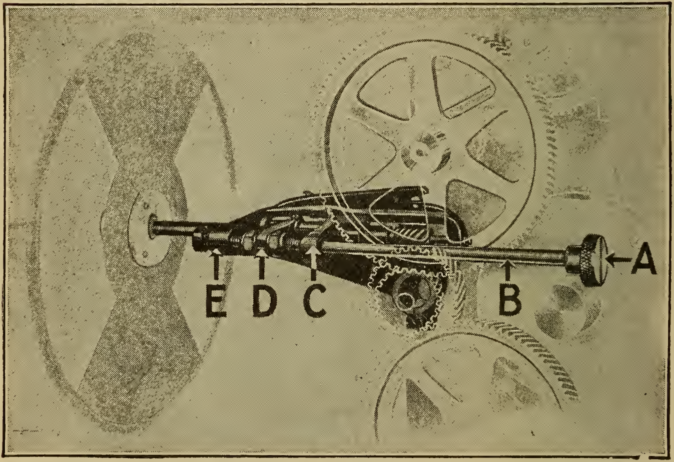


Figure 249.
Power's Adjustable Shutter Bracket.

these parts run on high speed, therefore, be sure and set up all the screws tight.

INSTRUCTION NO. 3—CAUTION.—Never leave the controlling lever down when the projector is standing still; always pull the lever clear up so as to disengage friction wheel R-15, P-14, from driving disc R-13, P-14. Failure to attend to this matter will probably result in flat spots on the friction material. In nine cases out of ten where flat spots develop it is caused through failure to heed this warning.

INSTRUCTION NO. 4—TENSION.—It is, of course, necessary that there be sufficient tension, or friction between material R-15 and driving disc R-13, P-14, to drive the projection mechanism, but anything more than sufficient to accomplish this purpose will merely result in undue wear of the friction disc, friction material and unnecessary consumption of power in the motor. The tension or amount of friction between friction material R-15 and friction disc R-13, P-14, is regulated by thumb screw R-32, P-12. Proceed as follows:

Loosen lock nut R-33, P-12, and loosen up on tension screw R-32, P-12, until friction material R-15 and disc R-32 are out of contact. Now, start your motor running and having set the controlling lever down so that the friction driving wheel is pretty well in on the friction disc, slowly tighten up on tension screw R-32, P-12, until the projection mechanism at-

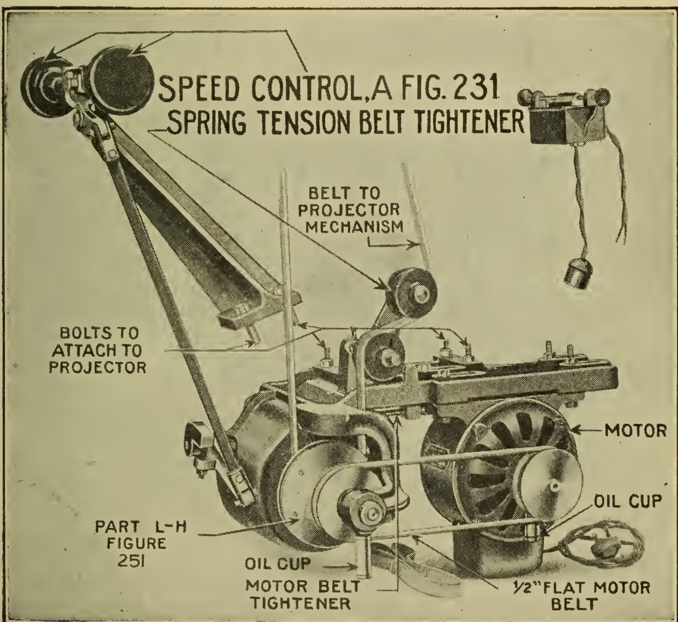


Figure 250.

tains full speed, and you are satisfied there is no slippage between the friction disc and driving wheel. Having done this, your tension will be just right, provided, of course, you have followed the instructions carefully, and have set up screw R-32 just sufficient to bring the projector up to full speed, this being done, of course with the film in the machine, or in other words, under actual operating conditions. After the proper adjustment has been obtained, do not forget to tighten up lock nut R-33 tight, or else the adjustment is likely to work loose.

INSTRUCTION NO. 5.—Grease cups (two of them) should be kept filled with some good lubricating grease (not oil, but grease), which may be obtained from any automobile supply store. The commutator of the motor may be reached by opening the two latticed cast-iron doors on the upper end of the motor.

INSTRUCTION NO. 6.—The motor may be disengaged merely by removing bolts R-6, P-13, and disconnecting its cable. When putting the motor back, be sure and line the

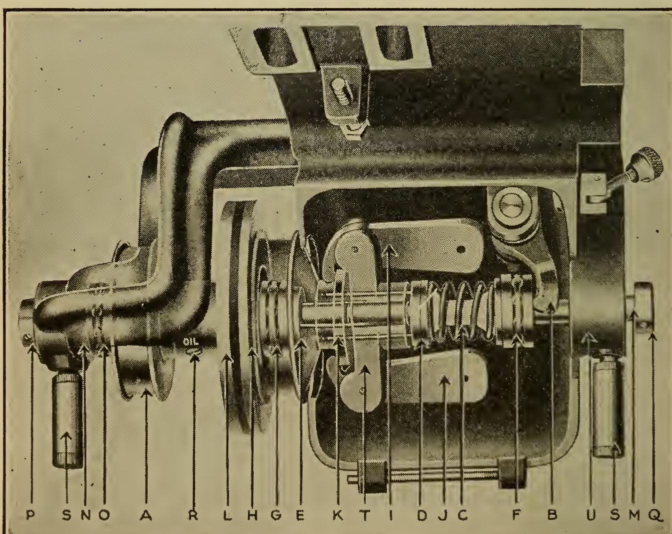


Figure 251.

shaft of the motor directly with the friction driving shaft R-25. If you don't do this, there will be trouble and probably more or less noise. In fact, should the device develop noise at any time, and you find that the friction wheel material is true, the next thing to look at is the alignment of these two shafts; it being possible that bolts R-8 worked loose and let the motor get out of alignment with the driving shaft R-25.

INSTRUCTION NO. 7—NO OIL.—With the exception of the motor bearings, none of the other bearings of this device require any lubrication whatever, this by reason of the fact that the bushings are all of material which requires no lubricaton.

THE POWER'S ADJUSTABLE SHUTTER BRACKET.—This is a very simple device by means of which the revolving shutter may be "set" or "timed," within certain limits, while the projector is running. It is illustrated in Fig. 249. The main advantage this device presents from the viewpoint of the projectionist, is that it is only necessary to set or time his shutter approximately correctly in the usual way, since he can make the finer adjustment by means of knob A after the projector is working. Instructions No. 28 and 32 contain matter concerning this bracket.

POWER'S FRICTION TYPE, GOVERNOR-CONTROLLED SPEED CONTROL.—This type of speed control is illustrated, as a detached unit, in Fig. 250. It is shown attached to the projector in Fig. 231. Its internal mechanism may be examined in Fig. 251. Fig. 250 is very largely self-explanatory.

Examining Fig. 251, shaft M has a collar, P and Q, on either end, and runs in bearings N and U. All parts between pulley A and part B, including ball bearings F, G and O, are mounted upon but are in nowise attached to shaft M. By this we mean that they simply use shaft M as a spindle upon which to revolve.

The action is as follows: The driving motor is attached directly to pulley A, Fig. 251, by means of an endless, flat, half-inch belt, as shown in Fig. 250. This pulley and part L form one part and revolve as a unit, part L being faced with a disc of friction material attached thereto by screws.

Part B is a fork which connects directly with and is controlled by knob H, Fig. 231. Ball bearings F, G and O act entirely as thrust bearings. They are not bearings within the ordinary meaning of the term. Their office is to carry the end thrust, which is the basic principle upon which the control operates.

HOW IT WORKS.—When speed control knob H, Fig. 231, is in position to stop the projector mechanism, it has moved fork B away from thrust ball bearing F, and has thus relieved spring C of all compression. This eliminates all friction between discs L and H. When knob H is in position to start the projector mechanism, it has caused fork B to shove bearing F endwise, which has the effect of compressing spring C and bringing discs L and H together under pressure, which will, of course, cause part L and pulley W to revolve, and thus drive the projector mechanism, pulley W being a part of disc H.

Understanding that pulley A and disc L are one piece, that pulley W and disc H are rigidly joined, and that both revolve freely on shaft M, pulley A being belted direct to the motor and pulley W direct to the projector mechanism, it will be seen that when discs L and H are pressed together by coil spring C, the projector mechanism will be driven by the friction set up between the two discs. That much is quite plain and simple.

THE GOVERNOR.—And now let us examine governor T, Fig. 251, and see what it is for. At any given speed of projection the "load" which must be pulled by the friction between discs L and H will require a certain, fixed amount of pressure by spring C to carry it. It will also be seen that exactly in proportion as projection speed is increased, the amount of the load to be pulled is increased, because increase in speed always requires an increase in expenditure of power.

When the projector is started, the entire force of spring C will be exerted to press friction discs L and H together, and the amount of driving force available will depend upon how much the spring is compressed, which in turn depends upon the position of speed control knob H, Fig. 231. As soon as disc H starts to revolve, however, the governor also starts to revolve, and governor arms J, Fig. 251, are thrown outward by centrifugal force. If you examine these arms you will see their ends are hooked, and that the hooks bear upon collar K, against the other end of which spring C presses. It therefore follows that any force exerted by arms J will act to compress spring C, hence to lessen the friction between discs L and H.

As speed is increased, the power exerted by arms J becomes greater, which, of course, means that they are carrying an increased amount of the pressure exerted by spring C, and in this way friction between the discs is decreased with increased speed until a point is reached where there is just enough left to carry the load at the speed knob A, Fig. 231, is set for, the difference between the speed of discs L and H being accounted for in slippage.

All this is very simple, once you understand it. We therefore recommend that you study the foregoing carefully.

TO DISASSEMBLE THE CONTROL.—All that is necessary to be done when taking the governor type speed control apart is to first let down the cover, which may be done by slipping out the latch holding it in place, and then loosen the set screw in collar P, slip the collar off the shaft and, holding the hand under the entire moving parts of the control, pull the shaft M out to the right, when all the parts will come away in the hand. When reassembling the parts great care should be exercised that they all be placed on the shaft in exactly the same position as before. The covered position of the various parts may be readily seen by referring to Plate 251.

OILING THE CONTROL.—This type of control does not lose its efficiency through oil coming in contact with any of the frictional surfaces, therefore oil may be applied to all parts without fear of making the control inoperative. A medium weight machine oil should be employed to lubricate all moving parts of the control, including the ball thrust bearings.

Particular pains should be taken to see that screw R, Fig. 251, is removed occasionally and oil forced into the oil hole, in order that the lubricant may reach the shaft M at the point upon which parts AL revolved. Also, as often as may be necessary, cup grease should be placed in oil cups S. These oil cups are wick oilers, and **only a light grade of cup grease should be used.**

POWER'S SPEED INDICATOR.—The Power's Division of the International Projector Corporation has what seems to be a very excellent speed indicator which may be ordered as special equipment for either the Power's or Simplex Projector.

The outfit consists of a small generator driven by belt from the mechanism. This generator generates a feeble current of electricity, the value of the current measured in milli-volts being directly proportional to the speed at which its armature revolves. Connected to the generator is an indicating instrument which is in reality a milli-volt meter but with two specially graduated scales, an upper scale indicating the speed of the machanism in feet of film per minute and the lower scale showing the number of minutes per thousand feet of film corresponding to the various speeds on the upper scale. By means of these two scales the projectionist can tell at a glance the speed at which the picture is being projected as well as the time required to project one thousand feet of film at that speed. For instance, if it is desired to project one thousand feet of film in ten minutes it will be seen by looking for the figure 10 on the lower scale of the indicator that the projector will have to be run at a speed of one hundred feet per minute.

In figure 251A the various parts of the speed indicator are shown as supplied for the Power's Projector. A special tool tray, A, figure 251A, having an extension, B, is attached to the projector stand immediately back of the lower fire shield and takes the place of the regular tool tray originally furnished

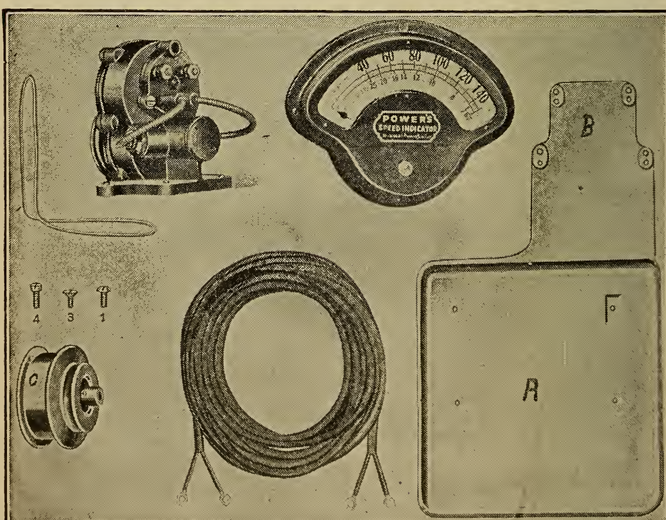


Figure 251A

which must be removed. The generator is mounted on the extension of the special tool tray by means of four machine screws supplied with the outfit. The generator is then connected by means of a small round belt to the motor attachment pulley of the mechanism. On all Power's Projectors manufactured within the last two years the motor attachment pulley is provided with a special groove for this belt. On older projectors a new motor attachment pulley is supplied to replace the pulley originally furnished.

The indicating instrument is usually mounted on the front wall of the projection room near the observation port where it can be readily observed by the projectionist. A special adjustable bracket is furnished for mounting the indicating instrument which permits the instrument to be tilted so as to bring its face at any convenient angle. The indicator is electrically connected to the generator by means of a six-foot length of cable supplied with each outfit.

One indicator and one generator are required for each projector. Additional indicators can be connected in the circuit, one usually being placed at the orchestra leader's music stand where synchronized music is used and sometimes another indicator is placed in the manager's office. By means of a multiple snap switch the generator on each projector is connected to the indicator circuit and this switch must be properly set at each change-over. The switch is provided with a small dial with the numbers one and two for a two projector installation or one, two and three for a three projector installation. These numbers indicate the proper setting of the switch for each change-over.

When the Power's Speed Indicator outfit is furnished for the Simplex Projector, the generator is mounted on a small bracket which is attached to the top of the Simplex mechanism. To attach this bracket the two screws holding the top magazine are removed and the bracket placed between the mechanism and the magazine support casting, using the two special length hexagon headed screws which are provided for this purpose. The generator in this case is driven from a small aluminum pulley which is slipped over the Simplex shutter spindle and held in place by set screws.

When indicating instruments are installed at a distance from the projection room—in the orchestra pit or manager's office—a small adjustable rheostat is supplied. This rheostat is usually installed on the front wall of the projection room and its purpose is to provide a means of balancing the resistance of the instrument circuit to compensate for the additional resistance of the run of wire from the projection room to the indicators located at the distant point.

INSTRUCTIONS FOR INSTALLATION.—The instruments should be connected as per diagram blue print furnished with the outfit.

The instruments have been calibrated at the factory with the adjustable arm of the resistance unit in a certain position, this position of the arm being indicated by a notch in the edge of the porcelain base and a scratch on the resistance arm. This resistance unit should be mounted on the front wall of the projection room.

No. 14 B&S insulated copper wire should be used to connect the various indicators.

After the installation is completed, the reading of the indicators should be checked with one of the projectors running at a known constant speed. The speed of the projector can be found by counting the revolutions of the crank shaft during one minute. If the speed of the indicating instruments does not correspond with the speed of the projector it will be due to the resistance of the wiring between the projection room and the indicators in the orchestra pit and manager's office. In this case the resistance arm should be moved until the indicators show the correct speed. This adjustment once made, it will not be necessary to touch the resistance unit again.

All indicating instruments furnished for any particular installation are interchangeable with each other, so that any instruments can be used for the projection room, orchestra pit, etc.

The snap switch included with the outfit should be mounted on the front wall of the projection room between two of the projectors. When Power's Instrument Panel is furnished, this switch will be mounted on one of the panels. By means of this switch the generator on either projector is connected to the instrument circuit. After each change-over, the switch knob is turned until the number of the dial on the switch corresponds to the projector projecting the picture.

CAUTION.—Do not tamper with the instruments or generators. If any trouble is not due to loose connections or faulty wiring, communicate with the manufacturers, stating the number of indicators and magneto-generators in the installation.

The Simplex Projector

THE Simplex projector is made in one model only, and is equipped with any one of the following types of light source and lamphouse, viz: "Type S," "Type N," Incandescent, High Intensity or the Peerless Reflector Arc lamp. There are also many attachments, special devices and equipment fully described in the company's literature.

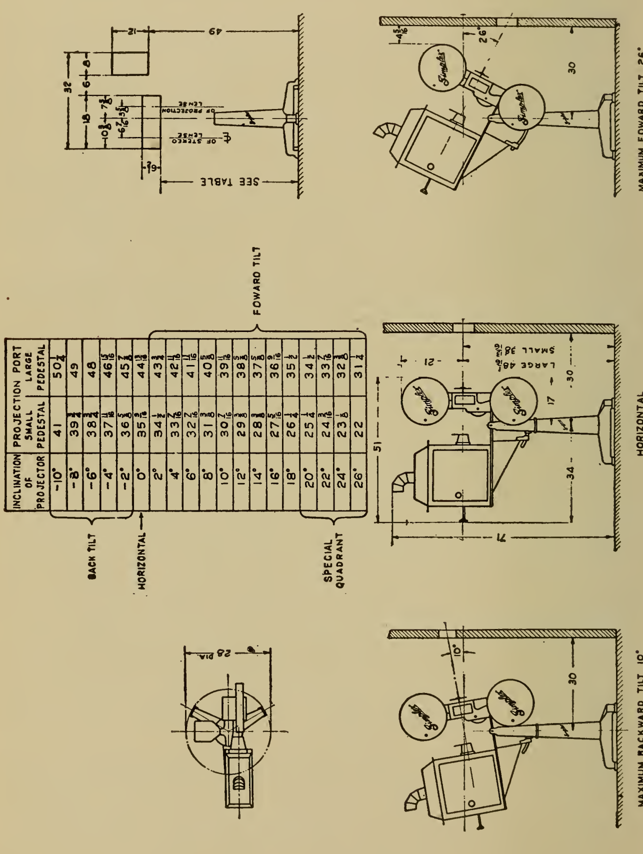
The Type S lamphouse is constructed of heavy Russian iron. The doors (one on each side) are double walled, with a half-inch air space between the walls through which a current of air passes constantly. The general ventilation of the lamphouse is excellent.

Fig. 253 illustrates the Type S lamphouse. Its dimensions are: Front to back, 26 inches; width, 13.5 inches; height from floor to top, 27 inches.

At the top is a vent, so arranged that connection may be made with a pipe leading either to the outer air or to the projection room vent flue. The maximum possible distance center of condenser can be placed from aperture is 19 inches, the minimum 10 inches. As shown in Fig. 253, the condenser casing swings outward on hinges to allow the projectionist quick and convenient access to the lenses for cleaning or replacing. The casing is locked rigidly in place by moving a single lever. Each lens is carried in a cast iron ring, and is retained therein by a threaded collar. These rings act as a heat and cold reservoir, equalizing the expansion and contraction of the thin edge and thick center of the lenses. The arrangement is an excellent one, but we would recommend the purchase of at least one extra ring, so that an extra collector lens, or even an extra collector and an extra converging lens, may be mounted in rings, all ready for instant installation in case of necessity.

CAUTION.—When placing lenses in the rings do not screw the retaining collar down too tight. Leave it just a little bit slack, else there will be no room for expansion, and the lens may and probably will bind and break. The ring and the threaded collar are shown in lower corner of Fig. 253.

Type S lamp is illustrated in Fig. 254. It is of rugged, rigid construction. It, of course, has all the necessary, usual adjustments. The carbon jaw holders are carried by two ½ inch steel bars placed 3¼ inches apart. Between them is a very coarse threaded screw by means of which the carbons are fed together. Its pith is such that one turn alters the distance



INCLINATION OF PROJECTOR	PROJECTION PORT SMALL PEDESTAL	PROJECTION PORT LARGE PEDESTAL
-10°	41	50¼
-8°	39¾	49
-6°	38¾	48
-4°	37 11/16	46 15/16
-2°	36⅝	45⅞
0°	35 9/16	44 13/16
2°	34½	43¾
4°	33 7/16	42 11/16
6°	32 7/16	41 11/16
8°	31⅜	40⅝
10°	30 7/16	39 11/16
12°	29⅜	38⅝
14°	28⅜	37⅝
16°	27 5/16	36 9/16
18°	26¼	35½
20°	25¼	34½
22°	24 3/16	33 7/16
24°	23⅛	32⅜
26°	22	31¼

LOCATION OF PROJECTION & OBSERVATION PORTS FOR SIMPLEX PROJECTOR

Figure 252.

of carbon tips 3/8ths of an inch. The carbon contacts are one inch deep, and the clamping device is a powerful one. The top carbon is clamped in the jaws by a ½ inch bolt, and the bottom clamping bolt is ⅜ inch in diameter. The arrangement is excellent, both by reason of size of bolts and because the nuts are four inches away from the arc.

The wire terminals are something like seven inches from the arc and of very ample dimensions. The device by means of which the wire is clamped insures perfect electrical con-

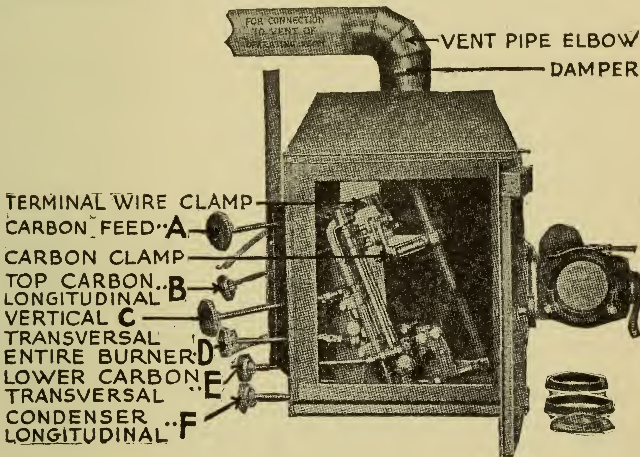


Figure 253.

tact. The insulation is so arranged that there is slight danger of carbon dust forming grounds. The whole lamp is heavy, rigid and well designed.

INSTRUCTIONS ON SIMPLEX MECHANISM

NOTE.—While these instructions may seem complicated, they really are quite simple. If they are followed carefully and accurately the projectionist will have little trouble in their successful application.. "P.I, "P.5," etc., means Plate I, Plate 5, etc. Reference to general instructions means the instruction beginning on Page 625, which apply to all projectors alike.

INSTRUCTION NO. 1. TO REMOVE FILM TRAP GATE, OR DOOR. A, P.2.—First shove knob S-134-E, P.2, in as far as it will go, which places gate or door in position shown in

P.2. Next lift up on gate, which should readily disengage from its holding pins. If it sticks so you cannot move it, set a stick of hardwood against its lower outside corner and tap gently with a hammer until it starts, whereupon it may be lifted out.

CAUTION.—Attached to lower end of gate or doors is the shoe or cradle which acts as idler to the intermittent sprocket. Under no circumstances apply pressure to this in an attempt to disengage the door or gate. If you do you may and probably will bend it, which means trouble. See Instruction No. 31.

INSTRUCTION NO. 2—TO REMOVE INTERMITTENT MOVEMENT COMPLETE AS A UNIT.—First remove knurled screw S-209-G, P.3, and pull the gear it holds in place off its spindle. Pull curved part of mechanism casing cover D-9, P.6, down, and lay a weight on it to keep it down out of the way. Open gates or door by pushing knob S-134-E, P.2, inward, thus preventing its interference with intermittent sprocket when you pull unit out. Loosen retain-

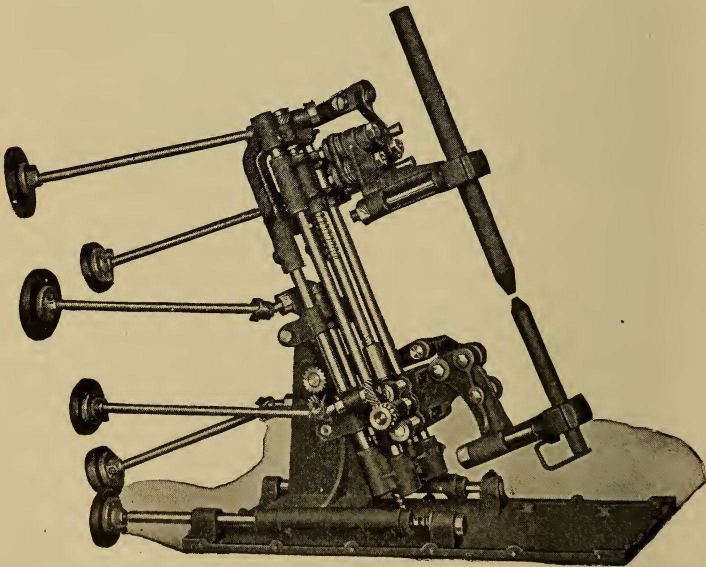


Figure 254.

ing screws S-157-B, P.2, (two of them) and shove locking ears they hold aside so they no longer engage with holding ring. Turn flywheel until set screw in collar C-192-G, P.2, faces lamphouse, then loosen screw and take collar off shaft. You may now pull the entire intermittent unit (which includes flywheel, intermittent oil casing and intermittent sprocket), together with gear G12, P 3, out on the flywheel side, grasping flywheel with right hand and gear with the left.

INSTRUCTION NO. 3—TO REPLACE INTERMITTENT UNIT.—This requires very careful work and an exact following of the instructions supplied. The operation is simple enough, but due to the fact that the intermittent casing must, in the very nature of things, fit into its holding ring accurately, it is quite possible to, by carelessness, or even by a comparatively slight error in procedure, do very serious damage to the parts. We therefore advise you to study the instructions carefully, and to **follow them exactly.**

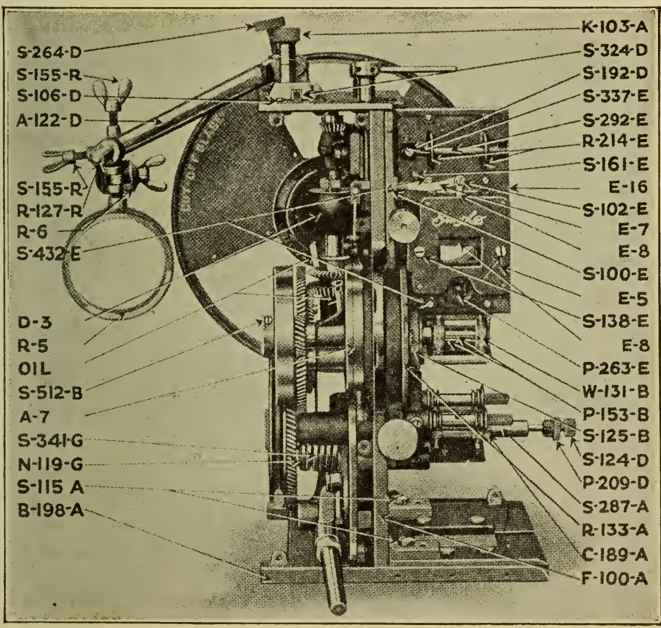


Plate 1, Figure 255

Hold intermittent unit in your right hand, by its flywheel. Mesh teeth of gear G12, P3, with teeth of small gear attached to inner surface of flywheel and, holding large gear in left hand, shove intermittent casing into opening A-7, P.4, at the same time entering shaft (S-444-G, P.4) of large gear into its bearing. Shove both gear and casing into place at one and the same time, being very sure dowel pin on framing can engages properly with hole in intermittent casing.

TAKE NOTICE.—It is essential to smooth running that the teeth of gear G12, P3, and the small gear it meshes with on flywheel shaft, be in the same relation to each other they were before they were separated. In other words the same teeth must be engaged that were engaged before disassembled. On outer rim of the large gear you will find stamped a cipher (0), and another on the rim of the flywheel, unless you have an old model mechanism, in which case you should turn

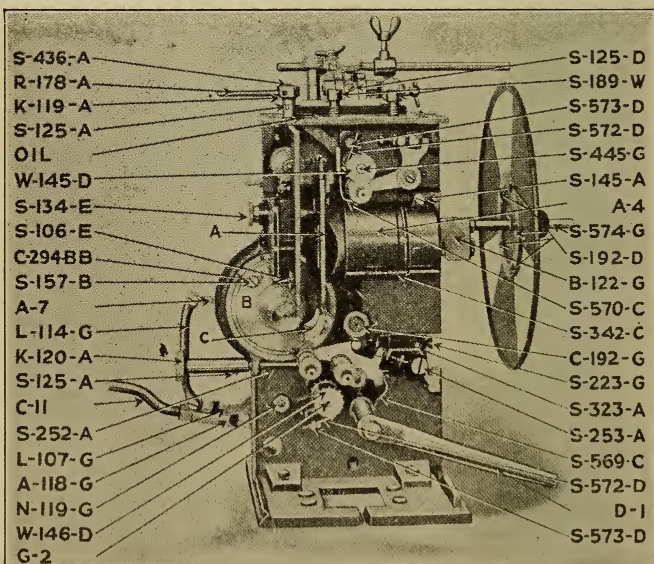


Plate 2, Figure 256.

flywheel until large end of pin in hub of gear on vertical shaft just under governor weights points straight out, and make a scratch mark on rim of large gear exactly opposite end of pin and another at edge of flywheel.

After intermittent unit and gear are in place pull intermittent casing out just far enough so that the two gears disengaged, and if the 0's are present, turn gear and flywheel until the "0" on each is in line with the other, whereupon mesh the gears. Then pull both gear and casing out until large gear disengages from gear on vertical shaft. You now have gear G12, P3, meshed with gear on flywheel shaft correctly, but not engaged with gear on vertical shaft, which is the second gear below governor weights on the shaft.

Turn flywheel and gear G12 until the "0" is exactly opposite center of vertical shaft, and turn vertical shaft until big end of pin is opposite the "0", whereupon shove the casing and gear home, put collar on opposite end of shaft of gear G12, replace gear G-112-G, P3, and its retaining screw, being very sure the clutch faces on shaft of gear G-112-G, P.3, engaged properly.

NOTICE.—Unless these clutch faces or shoulders do engage properly, the gear will not go clear on and the teeth of the two gears will not engage their full width.

Next engage locks C294BB, P2, (two of them) with rim or flange of framing cam, tighten their holding screws and the job is done.

INSTRUCTION NO. 4—ADJUSTMENT TO ELIMINATE LOST MOTION IN INTERMITTENT SPROCKET.—See general instruction No. 5, and study it. Remember that this adjustment is usually made when the mechanism is cold, and that the parts will expand through the normal heat of operation, which includes some heat from the "spot," which is carried through the metal. Therefore always make the test for lost motion in the intermittent sprocket immediately after running a reel.

First turn flywheel until intermittent sprocket stops, and then about a quarter of a turn more. You then know the movement or the star is "on the lock," as it must be for this adjustment. In the hub of the intermittent casing, B, P.2 or B-8, P.4, you will find two small screws. Loosen, but do not remove them, after which apply wrench end of Simplex spanner wrench, or some other suitable wrench to the hexagon nut between the intermittent sprocket and the bushing.

Turn this nut, which is a part of the bushing, one way or the other until excess circumferential play of sprocket is eliminated. When through, tighten the holding screws in the hub and the job is done, but be very careful as to the latter, as the screws have a tendency to clamp the star against the cam, in which case the adjustment made must be slacked off just a little bit. Be sure this does not happen. You can test it by trying the flywheel very gently. If it refuses to turn, or turns hard, then loosen the screws and slack off on the adjustment just a little.

CAUTION.—Do not get the movement too tight. There should be no lost motion in the sprocket, but at the same time the flywheel should turn freely. Before making adjustment, if the projector has been standing still for some time first run it a little to get the parts thoroughly covered with oil.

INSTRUCTION NO. 5—REMOVING AND REPLACING INTERMITTENT SPROCKET.—We do not advise you to

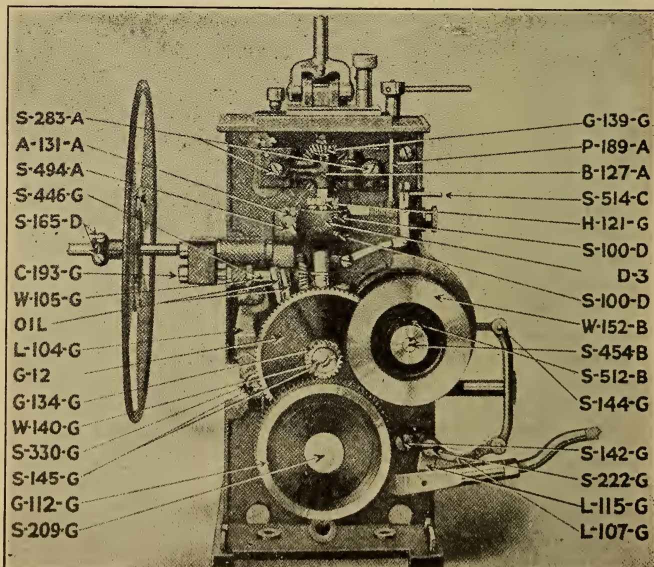


Plate 3, Figure 257.

attempt this, unless conditions compel you to do it. We strongly advise that you purchase an extra intermittent unit, and that when repairs are necessary you install the spare and ship the other to the factory, or to a Simplex distributor for expert attention.

Granted the removal and replacement of an intermittent sprocket is a simple operation, still it is one demanding such extreme accuracy that it is best done at the factory.

To remove intermittent sprocket, first follow instruction No. 2. Loosen the two screws in B, P2, as for adjusting star and cam, being sure you have them backed off enough to release. You may then, by exerting reasonable force, pull the intermittent sprocket, its shaft, the bushing and the star straight out of the oil casing. To remove sprocket and install a new one see General Instruction No. 5.

When sprocket is in place on shaft, insert star, bushing, etc., in casing, being very certain that star and cam engage properly, and tighten the two holding screws. To replace intermittent movement unit, see Instruction No. 3 You will probably have to re-set the revolving shutter; see Instruction No. 36.

INSTRUCTION NO. 6—END PLAY IN INTERMITTENT SPROCKET.—While a very small amount of end play or end movement of intermittent sprocket may do no harm, still there should be none at all. If objectionable end play should develop, which you are unable to trace to any other source, examine the pins which fasten the sprocket to its shaft. It is possible the holes in the sprocket hub have become worn out of oval or egg-shape, in which case the sprocket would have lateral motion equal to the amount of the wear. You can test this by the feel and by examining with a magnifying glass, such as a good reading glass. A condenser lens for a magnifier will hardly serve for this, though you might try it.

If you find the hole to be out of round, then secure from a Simplex distributor, or from the factory, a suitable reamer and, removing the sprocket by following Instruction No. 5 in the matter of taking out the sprocket unit, and using the anvil illustrated in Fig. 225, drive out the pin and ream out the hole in sprocket hub and shaft, being careful to ream out only just sufficient metal to make the hole round. You may then drive in two new pins and reassemble the parts.

INSTRUCTION NO. 7—REMOVING INTERMITTENT OIL WELL CASING COVER.—To remove this part, B, P2 and B-8, P.4, proceed as follows: First follow instructions No. 2 and 5. In the hub of the casing cover you will find a hole made to receive the pin of the Simplex spanner wrench. By holding the casing stationary and using this wrench you may unscrew the cover, which has an ordinary right-hand thread.

NOTE.—It will be necessary to tap the wrench gently with a small hammer in order to start the part, but remember when doing this that you are working with finely finished parts, made with extreme accuracy, therefor use a little common sense and do not abuse them.

INSTRUCTION NO. 8—REMOVING CAM OF INTERMITTENT MOVEMENT, B-16, P.5.—First follow instructions Nos. 1, 2 and 7. Next remove collar on end of shaft carrying the cam, whereupon you may pull the cam out, together with its shaft and gear.

INSTRUCTION NO. 9—TO REMOVE FLYWHEEL SHAFT, S-454-B, P.3.—First follow instructions Nos. 7 and 8, then loosen setscrew in hub of flywheel. Next pull flywheel off the shaft, which will carry with it gear G-148-B, P.4 and a small locking shoe. WARNING: Be careful lest you lose the locking shoe, as it is quite small. This will release the flywheel shaft, which may be pulled out at opposite end of bearing.

INSTRUCTION NO. 10—REMOVING COMPLETE FIRE SHUTTER GOVERNOR UNIT.—The fire shutter governor, D3, P.3, the vertical shaft on which it is mounted, and the gears on the shaft are for all practical purposes one unit. To remove any one of the parts it is necessary to do considerable in the way of preparation. First take off the upper magazine and remove screws which hold top plate of mechanism casing. Next loosen set-screw S-125-A, P.2, and lift off focusing knob K-119-A, P.2. Remove left door link screw and lift off top plate of mechanism casing.

Next follow Instruction No. 2, and then, using a small steel punch, being sure to drive from the small end of the pin, drive out taper pin (it will be a set-screw if you have an old model mechanism) in hub of gear G-120-G, P.4, which in the first gear below the governor weights. Next drive pin out of hub in next gear below. Remove center set screw from upper link holder H-121-G, P. 3, which will be a taper pin instead of a set-screw if your projector be an old model.

If you have followed these instructions correctly you have now released all parts mounted on vertical shaft, below its upper link holder H-121-G, which will be held by a taper pin. Should the shaft stick, line the jaws of a plier with heavy paper or thin sheet copper and, grasping upper end of shaft, using center wall of frame as a fulcrum, start the shaft by prying.

INSTRUCTION NO. 11—TO REMOVE SLIDING GEAR G-116-G, P.4.—This is just under the long gear on revolving shutter shaft, and which slides back and forth when framing. First follow Instruction No. 10. You may then remove both gear and shaft by loosening set-screw in collar C-193-G, P.3, on outer end of shaft, and pulling shaft out to the right.

INSTRUCTION NO. 12—REMOVING GEAR ON REVOLVING SHUTTER SHAFT.—To remove this gear, G-147-G, P.4, loosen set-screw in back end of gear and pull the shutter shaft out. Old model mechanisms have taper pin instead of set-screw. Next remove link screw of casing door and take out upper and lower screws holding left side of

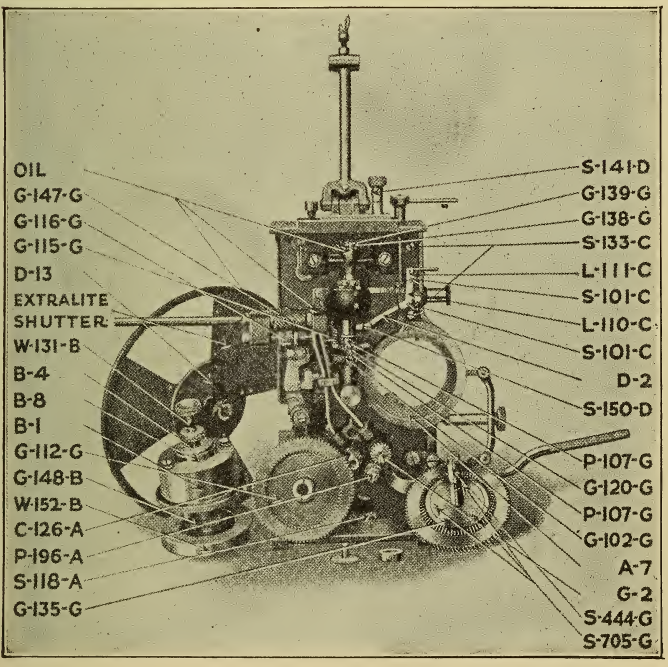


Plate 4, Figure 258

front mechanism casing, C-152-D, P.6. Remove this part and gear is released.

INSTRUCTION NO. 13—REMOVING REVOLVING SHUTTER BRACKET.—To remove this bracket, which carries revolving shutter gears and shaft, first follow Instructions Nos. 10, 11 and 12. Next release washer and screw holding framing lever spring S-330-G, P.3, about 3/16 of an inch and then apply blade of screw-driver to back side (side next lamphouse) of end of spring which points toward base. Push outward (toward screen) and the spring will release and unwind itself, probably with startling suddenness (which will do no harm), whereupon it may be removed with perfect safety. Provided your mechanism be a late model, you will find a hole in front mechanism cover opposite center wall of frame of mechanism, just over a set-screw. Loosen this set-screw, which will release the stud holding framing slide lever L-104-G, P.3, and pulling stud out will realease the lever. If mechanism be an old model and there is no hole by means of which you reach the set-screw, we would advise you to make a hole using a breast drill and a half-inch drill since otherwise you must remove the entire right hand front mechanism cover. Having removed framing slide lever L-104-G, P.3, you have now only to remove the screws (two of them) holding bracket to frame to release the bracket.

INSTRUCTION NO. 14—REMOVING REVOLVING SHUTTER SHAFT.—To remove the revolving shutter shaft, S-574-G, P.2, it is only necessary to take out set-screw in rear end of hub, G-147-G, P.4 This screw is quite short and has a pointed end which engages with counter sunk hole in shaft. Better (using a small magnetized screw-driver, if you have one), remove it entirely, but be sure you do not lose it.

INSTRUCTION NO. 15—REMOVING REVOLVING SHUTTER BLADE.—To remove revolving shutter blade from its hub (a very necessary operation in many circumstances), take out ten screws from shutter hub, if old model projector or shutter; or five screws, if late model. This releases blade from spider. In replacing, be sure the word "Simplex" (old style shutter), or the words, "Extralite Cut-off Blade," is directly in line with the heads of set-screws S-165-D, P.3.

INSTRUCTION NO. 16—TO REMOVE SHUTTER ADJUSTING SLIDE BLOCK S-323-A, P.2.—First follow Instruction No. 2, and parts of Instruction No. 13, afterward removing mechanism casing parts C-157-C, C-152-D and C-159-C, all P.6. Next take off top plate, P-207-D, P.6, of mechanism casing. Remove link screw S-181-D, P.6, and take out the framing slide lever as per instruction No. 13. Next drive out the stop pin near upper surface of lower track the block slides on. Loosen set-screw S-253-A. P.2, and turn shutter adjusting knob K-120-A, P.2, counter clockwise until it disengages from the block, whereupon you may pull the block out.

INSTRUCTION NO. 17.—TO REPLACE FRAMING SLIDE LEVER.—In Instruction No. 13 you were given directions for removing framing slide lever L-104-G, P. 3. Assuming that gear G-112-G, P.2, gear G-12, P.3, and the flywheel have been removed (see Instructions 2 and 9 for their removal), first place upper, forked end of framing slide lever in the slot on under side of casting which carries sliding gear G-116-G, P.4, so that the fork engages with block in framing slide. The lever itself is bow-shaped, and the outward bow must be forward—toward the screen. Next shove the stud

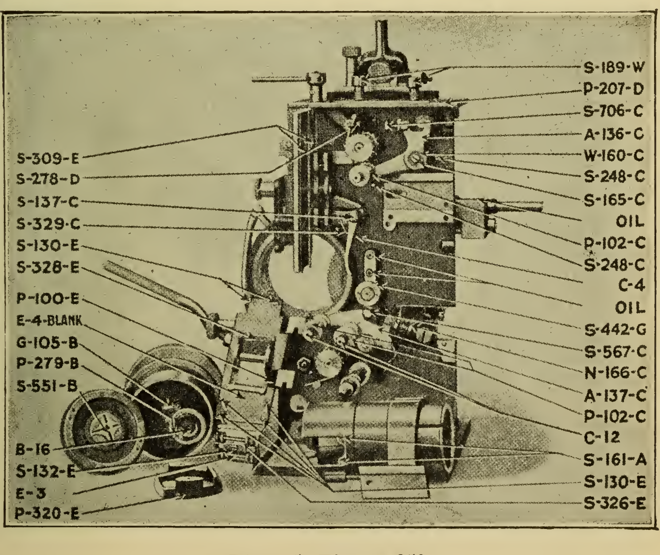


Plate 5, Figure 259

which holds the lever into place, being certain that set-screw S-223-G, P.2, engages with countersink in shank of stud. Screw set-screw down tight. Place coil spring on stud with the hook upward and toward the lever. Engage the hook with lever. Put washer and scre on end of stud but do not tighten scre down. Leave it quite slack.

In the end of the stud you will have noted a groove. This is to hold the spring when under tension. With the screw slack enough so you can do it, grasp the end of the spring which hangs downward and force it around to the right (clockwise) until it has made approximately one full revolution and points straight downward, whereupon snap it into the groove in end of stud. Hold the spring in this position and tighten the screw in end of stud down solid.

INSTRUCTION NO. 18.—REMOVING SHUTTER ADJUSTING KNOB AND SHAFT K-120-A, P.2.—Remove screw and washer which hold lower sprocket idler bracket to its shaft, or stud. Raise bracket away from sprocket and pull it off. Next loosen nuts which are locked together on threaded portion of shaft and, holding the nuts stationary, turn knob K-120-A, P.2, counter clockwise until it releases from sliding block and lock nuts. You may then putt it out.

NOTE.—On the older types of Simplex the removal of a single screw will permit of the entire arm being removed.

INSTRUCTION NO. 19.—TO REMOVE FRAMING CAM.—This is the part the framing lever link, L-114-G, P.2, connects to. It is numbered A-7, P.1. To remove it, first follow Instruction No. 2. Next remove screw S-222-G, P.3, which connects upper end of link to cam. Take out screws holding back mechanism casing cover, C-151-D, P.6, and remove same. With thumb of left hand shove framing slide lever, L-104-G, P.3, forward (toward screen) as far as it will go and insert a piece of wood about one inch thick between sliding gear, which is under large gear on main shutter shaft, and its bracket, to hold the gear and lever forward where you shoved them. A smaller piece between the lever and its stop will serve as well. The idea is to hold the lever where you shoved it, which relieves pressure of framing slide lever spring, acting through tension block, from edge of cam we are to remove.

Next, using a long, slender-bladed screw-driver, loosen set-screw in framing cam adjusting ring, R-133-A, P.1. This screw locks together the ends of the ring where they are cut. Its loosening unlocks the ring, which may be unscrewed and the framing cam worked slowly around until it is free, when it may be pulled out to the left.

To replace this cam is merely the process before described in reverse, but attention must be given the matter of tightening ring R-133-A, P.1, which must be screwed in far enough to eliminate any possibility of lost motion between the casing and its holding ring, but not tight enough to cause binding during the process of framing the picture.

INSTRUCTION NO. 20.—REMOVING AUTOMATIC FIRE SHUTTER LEVER E-7, P.1.—Unscrew stud S-514-C, P.3, used to raise the shutter. Remove lever screw, S-100-E, P.1, which is immediately over knob S-134-E, P.2, with which the gate is shoved open, and remove screw S-102-E, P.1. When this latter screw is out the fire shutter will drop down and the lever may be pulled out to the right.

NOTE.—If it be an old type mechanism there will be a set-screw instead of the lifting stud, which may be removed after taking off C-151-D, P.6.

INSTRUCTION NO. 21.—TO REMOVE AUTOMATIC FIRE SHUTTER E-8, P.1.—Remove link retaining screw S-102-E, P.1., which is the screw by means of which the link at top of shutter attaches to lifting lever. Next remove entire lateral guide roller unit, as per Instruction No. 22, whereupon you may lift the shutter out.

INSTRUCTION NO. 22. TO REMOVE LATERAL GUIDE ROLLER UNIT S-292-E, P.1.—To remove this or any one of its parts, loosen the set screw in its left hand hub and the screw in collar at opposite end. You may then pull shaft out to right, starting it out by prying against its left hand end with a screw-driver blade. The removal of the shaft releases all the parts.

CAUTION.—Before disturbing the unit examine it carefully and be sure you understand how the parts go. There are six of them, viz: a shaft, collar, spacing bushing, two rollers and a coil spring. This guide helps in holding the film central over aperature, hence disturbing the position of any of its parts would have a serious effect.

IMPORTANT NOTE.—The foregoing applies to all but the later projectors. With the later Simplex mechanisms you should release the screw holding the pivot on the right side—the side which is toward the glass door—pull out the pivot and remove the roller unit complete.

CAUTION.—In replacing the unit, be sure that it runs freely on the shaft, without binding and without end play.

INSTRUCTION NO. 23.—TO REMOVE GOVERNOR LIFT LEVER D-2, P.4.—It is only necessary to take out the screw in its right hand end, which joins it to the vertical link, and the fulcrum screw S-150-D, P.4. You may then life the part away.

INSTRUCTION NO. 24.—TO REMOVE FRAMING SLIDE LEVER L-107-G, P.3.—See Instructions Nos. 13 and 17.

INSTRUCTION NO. 25.—TO REMOVE AND REPLACE SPRING MOUNTED ON FRAMING SLIDE LEVER L-104-G, P.3.—See Intructions Nos. 13 and 17.

INSTRUCTION NO. 26.—TO ADJUST FRAMING TENSION.—If the framing handle shows tendency to work up or "creep," there is not sufficient tension. If the framing handle works unduly hard or sticks, the probable trouble is too much tension. Proceed as follows: Remove screw S-209-G, P.3, and pull the large gear it holds off its spindle. Just to the right of and below the spindle you will see a stud on the

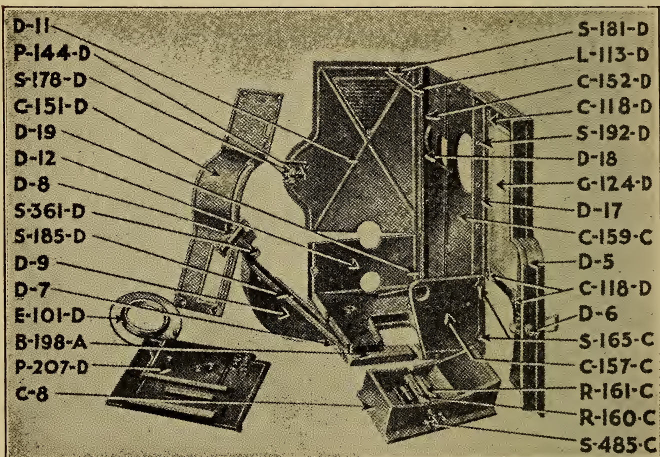


Plate 6, Figure 260.

end of which is two hexagons nuts. Behind these nuts is the coil spring which provides tensions for the framing device. Loosen the outer nut, which is merely a lock nut, and tighten or loosen the inside nut until the framing handle works to suit you, after which tighten lock nut again. The nuts are on stud P-196-A, P.4, and the spring is numbered S-341-G, P.1.

NOTE.—The Projectionist should be sure that there is no lost motion in the framing cam. If lost motion is present adjust.

INSTRUCTION NO. 27.—TO REMOVE FRAMER TENSION SPRING S-341-G, P.1.—First follow Instruction No. 26, only instead of merely loosening the nuts, remove them entirely and pull the spring off.

CAUTION.—In reassembling be sure and place washer at either end of spring.

INSTRUCTION NO. 28.—REMOVING FILM TRAP COMPLETE.—Should it ever become necessary to remove the entire film trap assemblage, E-1, P.1., as a unit, it may be done by taking out the two large screws S-133-C, P.4, and S-514-C, P.3, which releases the whole thing, but it is best to first remove the door, as per Instruction No. 1, to avoid possibility of damage to intermittent sprocket.

In reassembling it is absolutely necessary that the unit be accurately placed and lined, else the aperture will not be square with the lens. Have the engaging surfaces **perfectly clean.** Place the part in position engaging it with the locating pins and starting the two holding screws, tightening them down, but not solidly. Next (IMPORTANT), with the gate shoved back (open), place a straight-edge of metal, such as a machinist's six inchc rule (seale) on the film traik, or "trap shoe" as the Simplex folks lall it, letting the straight-edge project down past the sprocket. If the part is in line when the straight-edge lies flat on the film track, it will just touch the face of the intermittent sprocket. If the rule rests on sprocnet face and is held away from lower end of film track, or if it rests on track but does not touch face of sprocket, tap casting forward or back nntil track and sprocket face are exactly in line. When this is done, tighten up the two holding screws **tight.**

NOTE.—Since the lens holder and film trap must be re-aligned, and special tools are necessary to this operation. We advise against removal of the film trap except when absolutely necessary.

INSTRUCTION NO. 29.—TO REMOVE FILM TRAP STUD S-134-E, P.2.—This is the thing you shove the gate, or door, open with. To remove it is a simple matter. The knurled knob at its end looks like it is one with the nickeled stud, but it is not. What seems to be a nickeled stud extending into the casting is only a thimble of thin metal covering the steel stud beneath. It is held by the knurled knob. Wrap the knurled knob with either cloth or paper, to prevent marring its surface, and grasping it with a gas plyer unscrew it. It is an ordinary right hand thread. It holds a light, rather long coil spring under compression. The spring is between the nickeled thimble and the stud. Having removed the screw, take off the thimble and spring. You must next follow instruction No. 28 (or you may do this first), after which the stud and entire gate will be released. To reassemble, note reassembling instruction under Instruction No. 28.

INSTRUCTION NO. 30.—REPLACEMENT OF FILM TRACK SHOES.—Film track shoes, S-309-E, P.5, are subject to very heavy wear, and as soon as there is appreciable wear they should be removed and replaced with new ones, otherwise there will very likely be an out-of-focus effect visible from time to time on the screen.

The old type shoes are fitted with beveled edges which slide into a slotted groove in the film trap. To remove, first follow Instruction No. 2, then take out screws holding its upper end, one of which is shown at S-432-E, P.1. Remove guide rollers, as per Instruction No. 22. Remove entire intermittent unit as per Instruction No. 2. This latter is necessary because the part will not slide down past the intermittent sprocket. You may now slide the shoe down and out. The process of reassembling is merely a reversal of the foregoing.

Shoes of late design have four wearing edges. When worn they should shift from right to left, and vice versa. They may then be reversed and the back sides used in the same way. These shoes are released by taking out three small screws, S-432-E, P.1, the heads of which are on the film trap casting, under the heat shield, or cooling plate E-5, P.1.

CAUTION.—When installing a new shoe be sure the ends of the screws do not extend through the shoe or protrude on the wearing side. This is especially to be guarded against if the same screws removed from the old shoes are used. If they do, the end may be dressed down, using a very fine file, but great care must be exercised not to mar the guide rollers which protrude through the shoes near their top. It may even be well to, as a matter of precaution, remove the guide rollers, as per Instruction No. 22.

INSTRUCTION NO. 31.—INTERMITTENT SPROCKET IDLER SHOES.—The film is held to the intermittent sprocket by a cradle shoe, held in a steel apron attached to film trap gate, or door. This shoe performs the same office for the intermittent sprocket that the sprocket idlers perform for the other sprockets. The adjustment of the shoe or cradle is of great importance. Examine part C, P.2, and see exactly how it works. Note that the cradle held in the steel apron attached to lower end of gate, or door, is held in place by a flat spring which allows it to adjust itself to the surface of the sprocket, and to move back when a thick splice or a stiff splice goes through.

Note also that the adjustment must be made by observing the relation of the outer tracks of the shoe to the face of the sprocket. The adjustment should be such as will hold the film firmly to the sprocket, without undue friction, at the same time allowing sufficient movement to allow a stiff or thick splice to go through without trouble. In figures the adjustment should be such that when the gate or door is closed the cradle shoe will fit the curvature of the sprocket, and so that the shoe will push back about 1/64th of an inch away from the sprocket face, which is about the thickness of an ordinary business card.

The maintenance of this adjustment is of great importance. It is difficult to tell you just how to obtain it, since it must be done by bending the apron. It is largely a matter of knowing just what is needed (which we have told you) and exercising plain common sense.

INSTRUCTION NO. 32.—REMOVING PROJECTION LENS HOLDER.—Projection lens holder, A-4, P.2, may be removed by taking off the front mechanism casing cover C-159, P.6, and removing screw S-494-A, P.3. The whole tube and sliding block which carries it may then be pulled out.

To adjust lens in holder first loosen clamp screw at front end of top of lens holder. There are several adapters or bushings which fit inside the holder to reduce its diameter to accommodate various diameter lens tubes. Insert the proper adapter, according to the diameter of your lens tube. Strike the arc, and, without any film in, open the automatic fire shutter and block it open. Project the white light to screen. By means of focusing knob rod R-178-A, P.2, on top of mechanism, set lens holder at center of its travel. Then shove lens tube in or out until edges of light on screen are sharply focused, whereupon tighten clamp screw S-145-A, P.2, on top of lens holder. Final focusing will then, of course, be completed with focusing screw after picture is being projected.

NOTE.—When position of lens in holder has been finally fixed, make a scratch mark on lens tube barrel at front end of holder, so that when you for any cause remove the lens it may be correctly replaced by properly locating the mark.

INSTRUCTION NO. 33.—ADJUSTING UPPER AND LOWER SPROCKET IDLER ROLLERS.—The distance of idler rollers from spocket is determined by the adjustment of screws in idler roller brackets, S-706-C and N-166-C, P.5. See General Instruction No. 12.

INSTRUCTION NO. 34.—TO REMOVE UPPER SPROCKET IDLER BRACKET TENSION SPRING, S-570-C, P.2.—You may either remove the entire film trap, as per Instruction No. 28, or move the top plate of the mechanism casing and either make a special tool or secure an offset screw-driver for taking out the two screws at upper end of spring. The spring is the flat steel spring which extends down from the casting which forms the bearing for the upper sprocket shaft. Its lower end curves and engages the end of the idler bracket arm. The two holding screws are right opposite the end of the upper sprocket.

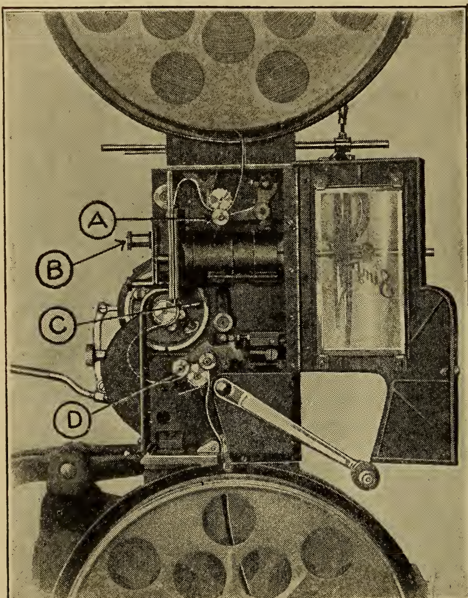


Figure 261

To replace this spring close the idler up against the sprocket and be sure you tighten the holding screws down solidly.

INSTRUCTION NO. 35.—TO REMOVE THE LOWER SPROCKET IDLER BRACKET SPRING.—It is only necessary to remove one screw. The spring engages with the casting forming the bearing of the main crank shaft. You cannot see the screw when the mechanism casing is in place, but you can feel it. You may take off front casing C-159-C to get at the screw, but by exercising a bit of patience you can remove and replace it, if you make a special screw-driver by breaking off an inch of an old hack-saw blade and grinding one end to a point, or (better) you may secure an offset screw-driver from Simplex distributor. In replacing the screw be sure you set it up tight.

INSTRUCTION NO. 36.—SETTING THE REVOLVING SHUTTER.—See General Instruction No. 22. The blade stamped "Simplex," or in the case of the Extralite, "Extralite Cutoff Blade" is the master blade. General Inst'n No. 22, P.644, will inform you fully as to the principle involved in shutter setting. Having studied general instruction thoroughly, so as to get a good idea of exactly what it is you wish to accomplish, place framing lever C-11, P.2, in central position, and by means of knob K-120-A, P.2, set sliding block S-323-A, P.2, in the center of its travel, which is midway between the two stop pins in its lower track. Next loosen the set screws which hold the shutter hub to the shaft just enough so you can pull the shutter around by exerting a little force.

Next place a finger of one hand on the intermittent sprocket and turn the flywheel IN THE DIRECTION IT NORMALLY RUNS until a point is reached where the intermittent sprocket just barely begins to move. Move the flywheel back and forth until you determine exactly the point where it starts the sprocket. Now hold the flywheel absolutely stationary and revolve the shutter on its shaft in the direction it normally runs, until the edge of the master is about three-fourths across the lens, which should be right.

Now turn the flywheel VERY SLOWLY in the direction it runs, until the point is exactly reached where the intermittent sprocket ceases to move. If the other edge of the master blade now covers as much of the lens as the other edge did, then the shutter is correctly set. If not, then equalize the two edges as to lens covering, and see instructions for adjusting revolving shutter to local conditions under General Instruction No. 22. When the job is done and a slight travel ghost shows up or down, but only one way, this may be eliminated by slightly altering shutter adjustment by means of knob K-120-A, P.2.

The shutter setting device is operated by knob K-120-A, P.2. It is for the purpose of adjusting the revolving shutter to correct any slight error in timing. The shutter must, however, be first correctly set as per the foregoing instructions.

INSTRUCTION NO. 37.—ADJUSTING GATE TENSION.— See General Instruction No. 9. Correct tension is that pressure which will cause film to begin to overshoot (picture to move up on the screen) when a speed ten revolutions of the crank shaft in excess of your highest projection speed is reached. Anything in excess of this is very bad for both the film and the projector mechanism. To change tension on the Simplex it is necessary to bend the spring which supplies pressure to the tension shoes. This is a curved flat spring, the upper end of which is seen protruding through a slot in the upper side of the lens barrel extension which attaches to the gate or door. It is attached to the door by means of two screws, the removal of which allows it to be lifted out. A magnetized screw-driver should be used for this job. A door should first be lifted off, as per Instruction No. 1. The springs should be bent without removing, but be very sure you bend both sides alike.

INSTRUCTION NO. 38.—The Simplex folks supply, on order, an undersize aperture to be used where it is necessary to eliminate keystone effect by filing. This aperture is about 1/32 of an inch less in size than the regular aperture opening.

INSTRUCTION NO. 39.—TO REMOVE APERTURE PLATE.—To remove aperture plate follow instruction 30, since film tracks must be taken out, then remove projection

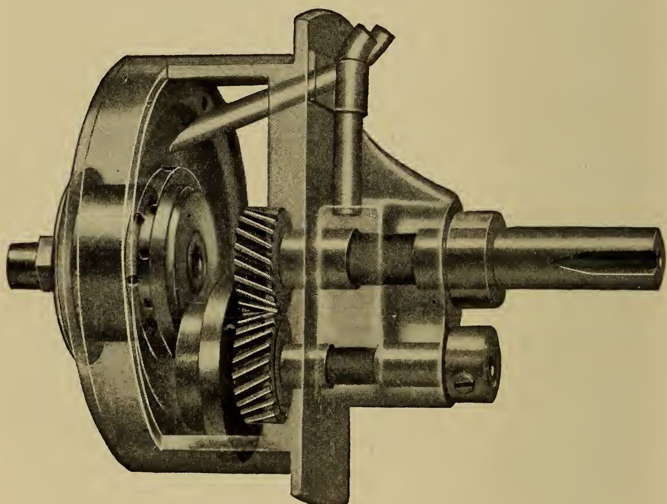


Figure 262.

lens tube by loosening clamp screw (S-145-A, P. 2, and pulling the lens out. Next, using a proper screw-driver, take out the two small screws which hold the aperture plate in place. They are not seen until the film track shoes have been removed. In replacing aperture, or putting a new one in place, be sure and set the screws up tight, else the plate may be held loosely and scratch the film.

INSTRUCTION NO. 40.—INTERMITTENT MOVEMENT.—In Fig. 262 the intermittent is shown with a part of the oil casing cut away, so that we can see the interior mechanism. The right hand side is the flywheel side. The cam, it will be observed, is the lower member, and is driven from the flywheel shaft by a gearing. What looks like a collar next the flywheel hub is not a collar but a part of the casting, as you may see by looking at your own mechanism. This illustration will be valuable to you when you are following the process of disassembling described in Instructions Nos. 8 and 9.

LUBRICATION.—This is of utmost importance as applies to the intermittent oil well. See General Instruction No. 1 **Use none but perfectly clean oil of good grade.** Under no circumstances use a light oil, such as Three-in-One. Looking at your mechanism, and Fig. 262, note that the oil tube nearest lamphouse carries oil to the oil well, where it ends directly

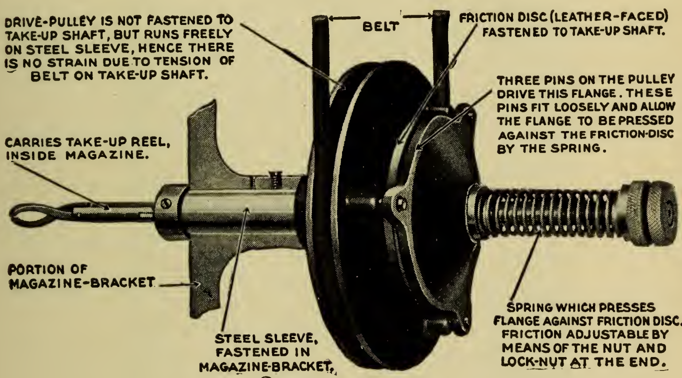


Figure 263

over the star and bushing. The other tube carries oil to the flywheel shaft bearing.

The oil casing should be filled about one-third full of oil. The manufacturer advises against using an oil can to put oil into the oil well, because of the likelihood of dirt getting into the casing. It **recommends the use of a glass syringe,** which may be had at any drug store. The glass barrel enables you to examine the oil before it is put in, and determine whether or not it is entirely free from dirt. Keep the syringe in a box, protected from dust, and wipe the tip clean before using. Small particles of dirt or dust may work serious damage to the closely fitted, highly polished parts.

In **Replacing** old intermittent parts after disassembly, or in installing new parts, **be sure they are perfectly clean.** If they seem to fit too tightly, have patience. These parts are supposed to and must fit snugly. **Never Force** a tight fitting intermittent movement part into place. If you do you probably will ruin the whole thing. If necessary, grind it down, using tripoli or rotten stone mixed with oil for the purpose. **Never Use Emory.** After grinding, wash the parts thoroughly with

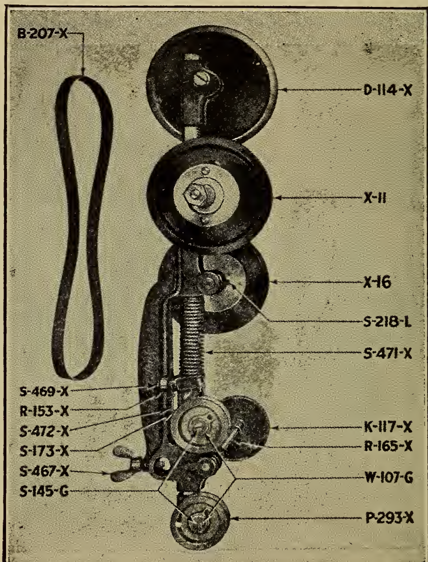


Plate 7, Figure 264.

kerosene or gasoline, and then lubricate with clean oil before inserting.

In Assembling an Intermittent Movement be sure the flywheel or cam shaft fits its bearing without lost motion. If there is lost motion, then send part to service station for attention. If shaft is too tight, grind it in with rotten stone, as before directed. Clean thoroughly with kerosene or gasoline, lubricate and place shaft in position, attaching flywheel to shaft and placing collar on end of cam shaft.

If gears do not run smoothly, then try meshing different teeth. If they cannot be made to run smoothly, then turn flywheel until cam pin is at upper point of its travel, directly under end of oil spout, and using a needle or other sharp instrument, make a mark on the flywheel gear by drawing the needle around the upper circumference of the cam. This is to aid in reassembling the gears after they are disassembled

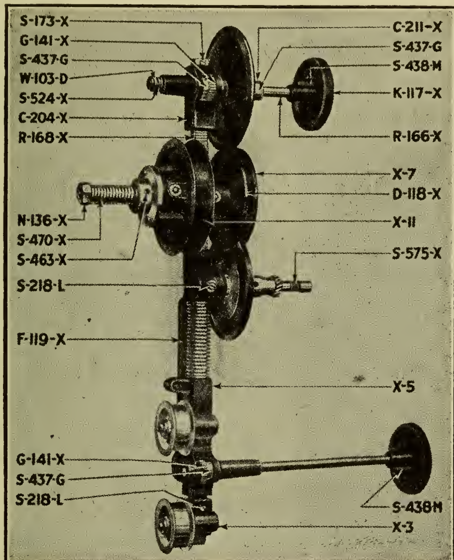


Plate 8, Figure 265.

Next apply to the gear teeth a small quantity of a paste composed of Arkansas powder mixed with oil, and holding intermittent casing with gears down so that the grinding paste will not enter bearings, rotate the flywheel backward and forward until the gears are ground in and run smoothly, whereupon take out the parts and cleanse them thoroughly in a bath of kerosene or gasoline. Repeat grinding process if necessary. In reassembling have shafts and bearings perfectly clean and lubricated with good oil. Be sure gears mesh as they did before, by observing mark you made on face of flywheel gear. If gears grind in spots only, then apply grinding powder to tight spots only.

CAUTION.—These gear grinding, shaft-fitting directions are **not** recommended by us, except under conditions where they are absolutely necessary. Our advice is to have a spare intermittent movement and send the one requiring repairs to a service station or to the factory. We have given them because there are circumstances where the projectionist may be compelled to attempt a repair which will involve these things.

The rotten stone (Tripoli) and Arkansas powder may be had from the Simplex factory or from a Simplex distributor.

LUBRICATING AND ADJUSTING DOUBLE BEARING INTERMITTENT MOVEMENT.—For the oil box end of the movement all lubrication is applied through the main oil cup, which is the cup covered by a cap. Oil placed in this cup reaches all the shafts and bearings at that end of the movement, as well as the star and cam.

TAKE NOTICE.—Before oiling through this cup, set the intermittent movement casing, by means of the framer, so that the oil cup is in central position and pointing straight up.

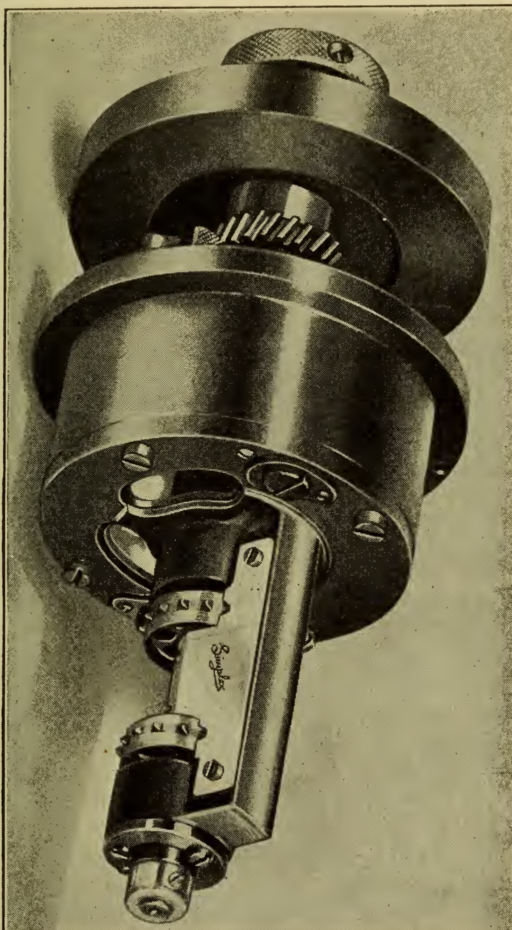
With the cup in correct position, as above, watch the glass oil gauge on the cover of the intermittent oil well, while you feed oil into the cup until the oil level reaches the mark, which is just half way up the glass.

WARNING. NEVER PUT IN SO MUCH OIL THAT IT REACHES THE TOP OF THE OIL GAUGE GLASS. HALF WAY UP IS JUST RIGHT.

THE OUTER BEARING of the intermittent sprocket shaft is oiled by means of an oil cup located on top of the flange of the outer bearing arm. This cup is closed by means of a steel ball, which must be pressed down by the tip of the oil can snout when injecting oil. ONE OR TWO DROPS IS ENOUGH. Over-oiling will result in oil reaching the film, hence must be avoided.

TO ADJUST THE MOVEMENT, remove it from the mechanism. See instruction No. 2, page 708. Place movement on bench, with main oil cup in central position and pointing straight upward. Place the movement "on the lock." That is to say, rotate the flywheel until the intermittent sprocket cannot be moved, setting it as nearly as you can midway between the two points where the sprocket may be moved.

Loosen, but do not remove, the six screws which hold the cover of the casing, whereupon the weight of the loosened



Simplex Double Bearing Intermittent Movement and Sprocket.
Figure 266.

cover will, if the casing has been placed in the position specified, itself push the star against the cam by gravity, thus providing the required adjustment.

BE CAREFUL NOW and so hold the cover that it cannot move, while you retighten the holding screws. Do NOT tighten one screw tight and then the next one, etc. Set one screw down until it just snugs the cover to the casing, then set the opposite one the same, after which do the others the same. Then give each screw, in its turn, a slight turn, until you have them all pulled down tight.

END PLAY OF FLYWHEEL may be remedied as follows: Loosen, but do not remove the screw in the knurled knob on end of flywheel shaft. Insert point of screw-driver into slotted end of flywheel shaft and turn same TO THE LEFT to decrease the end play. If too tight, turn to the right. You will find these directions, or their equivalent, stamped on the nut itself.

END PLAY IN CAM. This may be overcome as follows: Remove entire movement from the mechanism—see instruction No. 2, page 708. Lay on bench and remove knurled knob from end of flywheel shaft by turning to the RIGHT. Caution: This nut is locked to the shaft by means of a small set screw in its edge. Loosen this before attempting to remove the knob from the shaft. Having removed the knurled knob, pull flywheel from shaft.

Next remove the six screws which hold the cover of the oil well, and remove the cover. WARNING: In removing cover of oil well, be careful and do not injure the paper gasket upon which it seats. Next loosen, but do NOT remove, screw in the knurled collar on the end of the cam shaft. With the fingers of the left hand, hold the cam itself, inside the oil well, while you turn the knurled collar on the end of its shaft to the RIGHT until the desired adjustment is had, which will be when the cam turns freely, without either friction or end play to its shaft.

NOTE.—By loosening the locking screw in knurled collar on end of fly wheel shaft and turning knurled nut to the right, this adjustment may also be accomplished, but it is strongly recommended that the plan above set forth be followed.

WARNING AND CAUTION.—Whenever it becomes necessary, for any reason, to remove the oil well cover, the relation of the star and cam MUST be fixed in accordance with the previous instruction titled "TO ADJUST THE MOVEMENT." Do not neglect this warning unless you are looking for trouble.

END PLAY OF INTERMITTENT SPROCKET SHAFT.—To eliminate this, loosen, but do not remove the two set screws in the collar on the end of the intermittent sprocket shaft. With two fingers of the left hand pull the sprocket toward the outer bearing, at the same time, using the thumb of the same hand, shoving the collar on the outer end of the shaft inward, against the bearing. In other words, force the sprocket and collar towards each other and against the bearing, holding them thus while you tighten the holding collar set screws. USE JUDGMENT, however, and do not exert sufficient force to set up undue friction between the hub of the sprocket, the collar and the bearing.

TO REMOVE THE INTERMITTENT SPROCKET, first remove the entire intermittent movement unit from the mechanism and take the cover from the oil well, as per the directions previously given. Remove the intermittent stripper, which is the metal shield between the rims of the intermittent sprocket. Take off the collar on the outer end of the intermittent sprocket shaft. Then, using a sprocket pin tool, which may be procured from any simplex distributor (without this tool you should not undertake the removal of an intermittent sprocket at all), remove the two pins which hold the intermittent sprocket to its shaft.

WARNING.—Do not hammer, or in any way mutilate the sprocket pins. You must do this job RIGHT, or NOT DO IT AT ALL.

Having removed the pins, holding the framework of the unit firmly, proceed to pull the intermittent sprocket shaft and star out at the oil well end, placing the end of a stick of hardwood against the shaft and tapping it lightly if necessary.

In this connection we strongly recommend to your consideration General Instruction No. 5, page 631, or that part of it titled "Spare Intermittent Movement." Also the instruction concerning installing an intermittent sprocket on its shaft, page 712. If you force an intermittent sprocket on its shaft, it is ten chances to one that an unsteady picture will result.

THE TAKEUP.—The Simplex takeup is illustrated in Fig. 263. See General Instruction No. 23. The illustration, taken in connection with General Instruction No. 23 seems to supply all necessary instruction.

SIMPLEX SPEED CONTROL.—The control by means of which projection speed is regulated is positive in its action. Its flexibility is such that any speed desired between a minimum of, say, 40 and a maximum of 140 feet per minute may be had.

Examining plates 7, 8 and 9, which are respectively side, top and sectional views of the device, you may readily understand the operating principle, the idea being to cause mechanism driving discs X-16, P.7, to be grasped and driven by friction discs X-7 and D-118-X, P-9, and to provide means by which the projectionist may, by a conveniently located speed adjusting knob, (S-438-M, P.8), either thrust disc X-16 further between the driving discs, in which case it will be driven

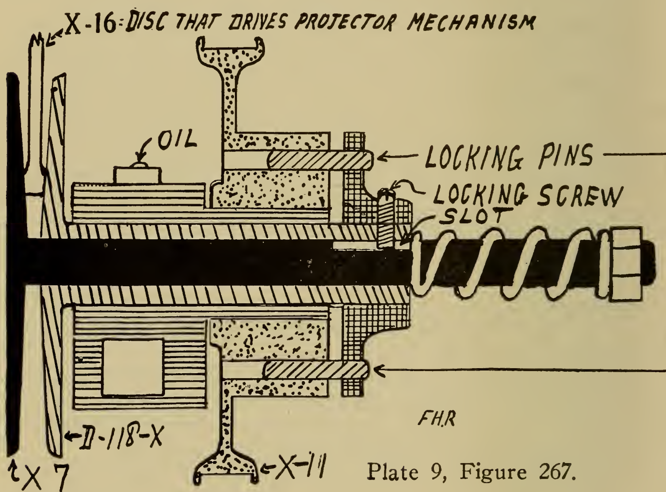


Plate 9, Figure 267.

Bearing carriage whole assemblage, Disc D-118, revolves inside it, and main belt wheel X-11 outside it.

Interior friction disc X-11

Exterior friction disc and shaft.

Main belt wheel.

Locking washer.

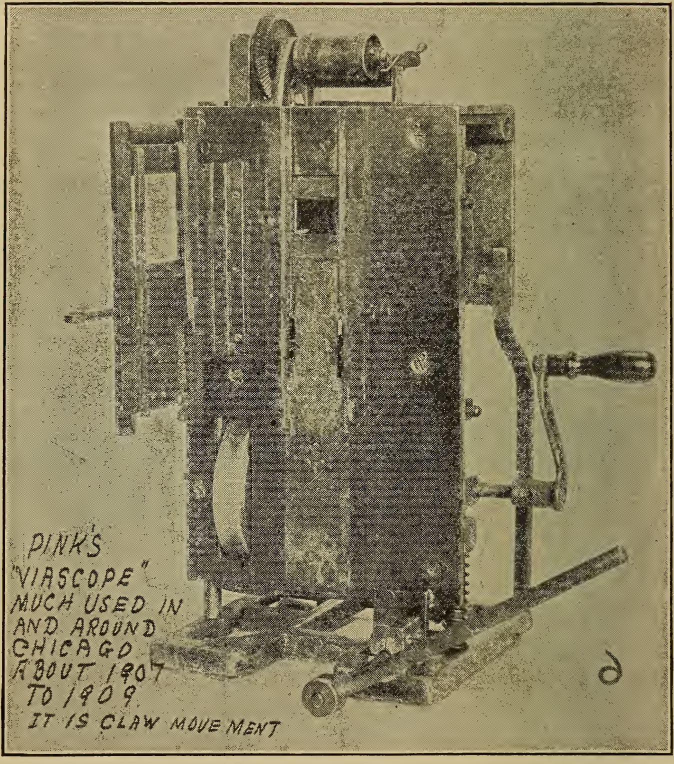
more slowly, or withdraw it further out so that it will be driven more rapidly. All this is readily understood from an examination of the various plates.

OIL.—The two main bearings have oil holes held normally by a spring supported steel ball. To oil, press the balls down with snout of oil can and inject one or two drops of oil. Other bearings have plain, open oil holes.

CAUTION—If you have an old style take-up which has a fibre disc, then do not get oil on the friction discs. Should you do so, dip a cloth in gasoline and wash disc, X-16, plate 9, and draw it between the faces of the other discs until all oil is removed. Oil on discs will cause slippage. Keep them clean.

ON THE OTHER HAND, if you have the later type which uses a leather disc, X-16, it, the leather disc, must be oiled before using. Never use this disc in a dry condition. Place a few drops of machine oil on it occasionally, so that it is kept soft and pliable, instead of hard and dry.

CAUTION.—In Fig. 270 you will observe a hole in which is the end of a shaft. Under the hole is a wing nut. The shaft protrudes from the projector frame casting, in which there is a hole to receive it Be sure the shaft is in place in the frame casting, and that it is in the hole in the controller casting and clamped by the wing nut, else the control will not set right or be properly supported.



Historical Plate

Motiograph De Luxe Model

THE Motiograph, De Luxe Model, has a lamphouse of ample dimensions. At the time this work goes to press there is a lamphouse and lamp of heavier construction in process of making. The present lamphouse (1921) is illustrated in Fig. 274 A. The metal is of heavy Russian iron. Doors are double walled, with a 5/8 inch ventilated air space between. Top has a vent for attaching to a pipe leading to open air or projection room vent flue. Dimensions are, front to back 16.5 inches, Fig. 274 A, with a recess under the condenser, which allows of bringing the arc very close to condenser. In effect it adds 2 7/8 inches to length of lamphouse. Floor to top of gable is 28 inches.

The condenser casing is so arranged that the projectionist has easy access for replacement or cleaning. The condenser lenses are held in metal rings which are calculated to equalize expansion and contraction of thin edge and thick center of lenses, which to an extent controls breakage. There is means provided for altering distance between collector and converging condenser lenses at will. The dowser is an "outside" one. Maximum possible distance obtainable between center of condenser and aperture 21 inches; minimum distance 13 inches. Minimum distance crater may be placed from face of collector lens when lamp is at ordinary working angle, 2 5/8 inches.

The arc lamp wire terminal clamps are shown in Fig. 274 B, details of the clamp being clearly shown in the picture. The carbon clamps are made of a fine grade of gray iron. They have a plunger of steel. The gripping surface is sufficient to insure good contact between clamp and carbon.

USEFUL DATA.—The following tabulation shows necessary distance of center of Motiograph De Luxe model pedestal from wall when projector is set at different angles, allowing a five inch clearance between upper magazine and wall at all angles. In this you will of course understand that as the projector is tilted at an angle the upper magazine is moved forward toward the wall, therefore the base must be moved back correspondingly. These figures will be of use in determining the position of the wire outlets and front to back length of the room when same are being planned.

Angle	Distance in Inches	Angle	Distance in Inches
0°	28 4/16	11°	36 3/16
1°	29¼	12°	37 1/16
2°	30	13°	37 9/14
3°	30¾	14°	38 3/16
4°	31⅜	15°	38¾
5°	32 3/16	16°	39½
6°	33	17°	39⅞
7°	33 9/16	18°	40¾
8°	34 3/16	19°	41⅜
9°	34⅞	20°	42 1/16
10°	35 9/16		

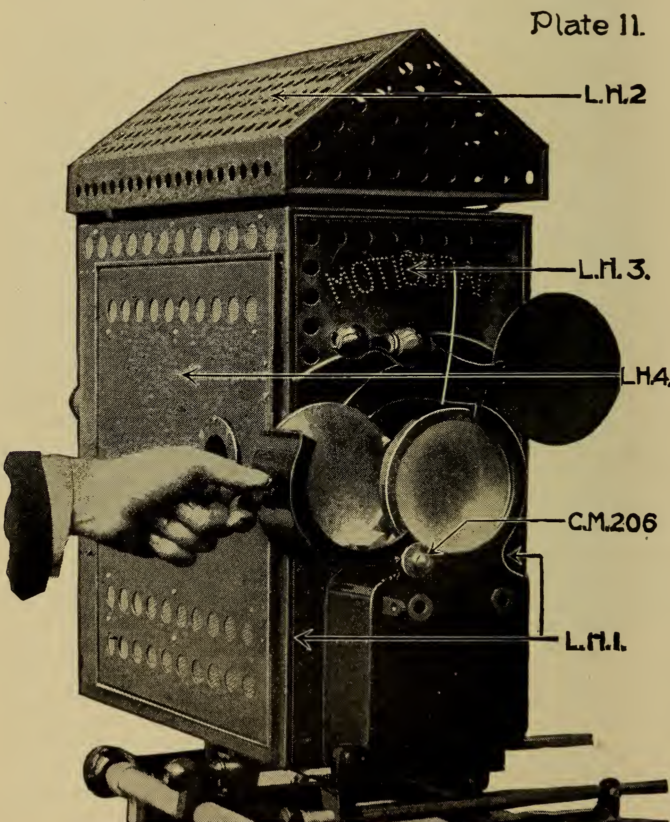


Figure 274 A

INSTRUCTIONS FOR MOTIOGRAPH DE LUXE

NOTE.—The instructions may seem complicated, but really are simple. If followed intelligently and accurately the projectionist should experience no difficulty in their application. "P.1," "P.3," etc., means Plate 1, Plate 3, etc. Reference to general instructions means the general instructions which apply alike to all projectors. They begin on page 592.

INSTRUCTION NO. 1.—TO REMOVE THE FILM GATE, CS-4.P.2, Raise gate latch CS-33,P.2, and pull lower part of gate outward until it stops. Press the two hinge knobs CS-20,

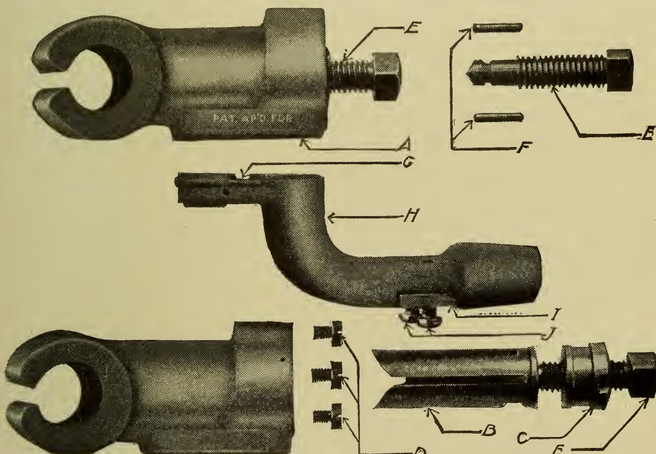


Figure 274 B

P.2, towards each other until the hinge pins are released. Remove top part of gate from between the hinge joints. Unhook film gate stop CS-158,P.5, from gate and disengage gate slide link SF-84,P.5, whereupon gate slide CS-97,P.5, may be removed by sliding it upward on the film gate to allow screw heads CS-116,P.5, to pass through openings in ends of the slots on gate slide.

INSTRUCTION NO. 2.—TO REMOVE AUTOMATIC FIRE SHUTTER CS-246,P.5, first remove the two screws CS-88, P.5, and then circular plate CS-86,P.5. Rack lever CS-72,P.5, may be removed by removing screw CS-79 from boss CS-75, P.5, at center of lever.

TO RAISE AUTOMATIC FIRE SHUTTER BY HAND

press pin CS-77,P.2, to the left. This pin projects from upper left hand corner of gate.

INSTRUCTION NO. 3.—TO REMOVE FILM TENSION SHOES CS-105 and CS-107,P.5, from film gate slide CS-97, P.5, take out screws (4 of them) CS-109,P.6. The tension springs which act on these shoes lie between the shoes and the gate slide, with their ends against the gate slide. Screws CS-109 pass through slots in the ends of the springs.

NOTE.—WHERE MUCH FIRST RUN, WAXED FILM IS PROJECTED, washers may be had for use under screw heads CS-109,P.6, of the two upper tension shoes. These washers release the tension of the springs, so that the tension shoes are guides only.

INSTRUCTION NO. 4.—TO REMOVE CRADLE CS-249, P.5, which holds film to intermittent sprocket, take out screw holding spring (not shown) which governs the cradle. Re-

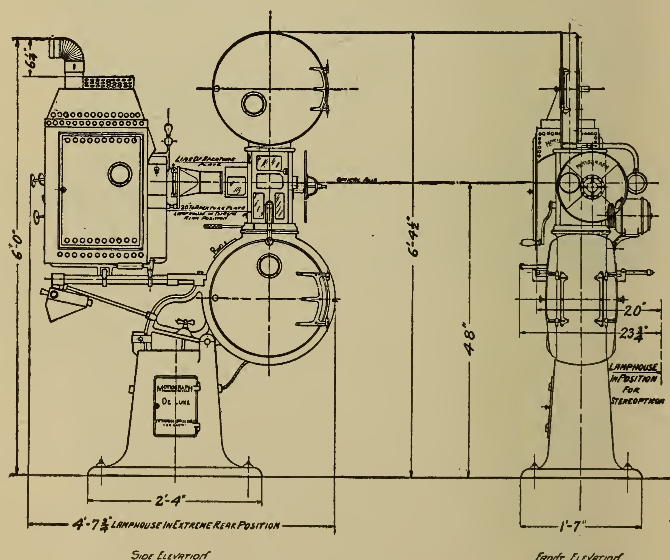


Plate I, Figure 275.

Dimensions of Motiograph De Luxe Model. These dimensions may be depended upon, taken in connection with the tabulation under "Useful Data," for use in locating wire outlets, etc.

moval of spring releases cradle, or, as the manufacturer calls it "intermittent sprocket film tension."

NOTE.—Under the spring is a collar, stock number of which is CS-188, and on top of the spring is a washer, No. CS-189. It is important that collar and washer be in place.

INSTRUCTION NO. 5.—TO REMOVE FILM GUIDE ROLLERS CS-101 and CS-102,P.5, or film guide roller CS-93,

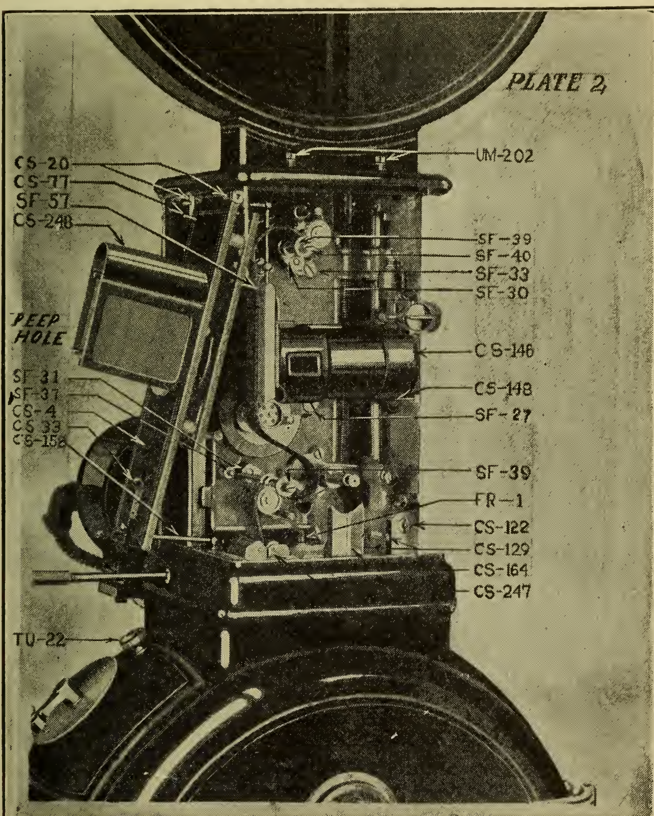


Plate 2, Figure 276.

P.5, the first two being at top of film gate slide and the last named at bottom of intermittent sprocket cradle, it is only necessary to take out the screw shaft which holds them.

INSTRUCTION NO. 6.—TO REMOVE ENTIRE INTERMITTENT MOVEMENT GB-75,P.3, AS A UNIT, including oil casing, flywheel and intermittent sprocket, open gate in order that intermittent sprocket cradle, or tension shoe, be released from sprocket. Next loosen screw CS-127,P.6, a few turns. Remove screw SF-21, from back end of crank shaft. Push crank shaft out of main gear toward operating side of mechanism. Remove main gear, loosen clamp screws SF-10, P.6, and slide washers they hold (SF-12) away from flange of geneva intermittent box, or oil casing. Grasp flywheel with left hand and pull it straight out until the geneva box is partly removed from frame, then turn the box about one quarter turn to the right and pull it out.

IN REPLACING GENEVA INTERMITTENT BOX, see that the "notch" on the rim of the casting is upward, and that it engages with stud SF-II, P. 6, the stud being at top of opening in frame into which intermittent box fits. The box of necessity fits closely into the frame opening. Do not force it in, but work it gently into place. It will go when you have it right. If you try to force it you may do great damage.

INSTRUCTION NO. 7.—TO OPEN THE GENEVA INTERMITTENT BOX, or oil well, GB-75, P. 3, first follow Instruction No. 6 and then remove the four screws GB-17, P. 8. The cover is not threaded to the box, but is prevented from turning and is held in proper relationship to the box by dowel pin GB-5, P. 8. The cover is machined to an oil-tight fit, hence must be handled very carefully. If it be struck or scratched by anything, then when it is replaced the joint will in all human probability not be oil tight.

CAUTION.—In replacing the oil well cover be very careful that both surfaces are **perfectly clean**, but wipe them with a clean soft cloth only from which all lint has been removed. Also that pin engages with cover made to receive it.

INSTRUCTION NO. 8.—TO REMOVE INTERMITTENT SPROCKET, SHAFT AND STAR, first follow Instruction No. 6 and then loosen screws GB-21, P. 3, which hold stripper plate stud GB-19, P. 3, to the cover and turn stripper plate GB-18, P. 3, away from sprocket. The intermittent sprocket is held to its shaft by two taper pins. Before attempting to remove these pins study general Instruction No. 5 carefully, and either use V block shown in Fig. 225 or its equivalent. Removal of the pins will release both sprocket, star and shaft.

NOTE.—We do not advise the projectionist to attempt any job which involves removal and replacement of intermittent sprocket. We strongly advise the purchase of a spare intermittent unit, and that when such a repair becomes necessary

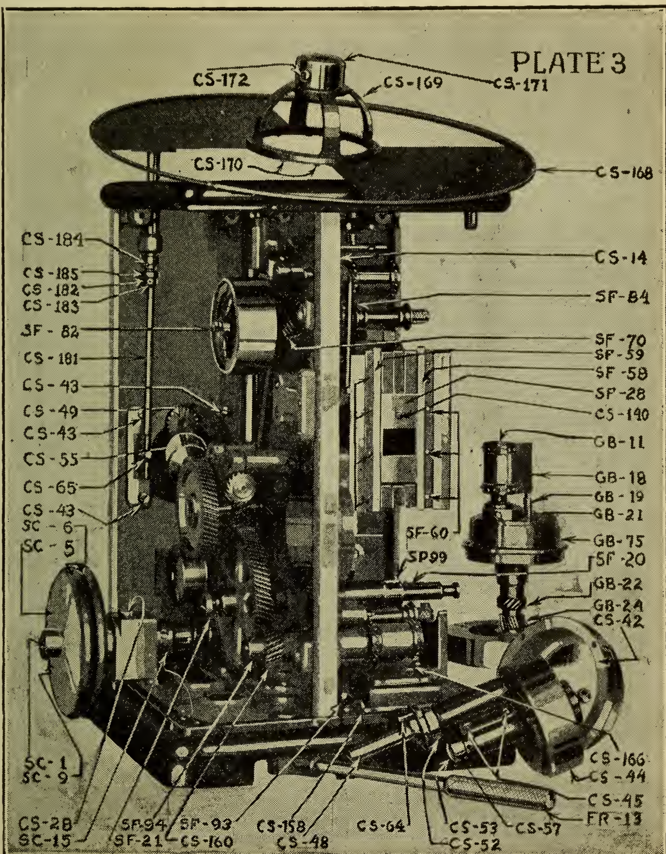


Plate 3, Figure 277.

that the spare be inserted and the unit in need of attention be sent to the factory, which is the only place such a job can be done right. We give instructions, yes, but only to help those who are by circumstances forced to attempt the removal and replacement of an intermittent sprocket.

INSTRUCTION NO. 9.—TO REMOVE THE CAM ELEMENT OF INTERMITTENT MOVEMENT, GB-77, P. 8, first follow Instructions Nos. 6 and 7. Next remove screw GB-26, P. 4, which is screw in end of flywheel shaft, and key washer GB-25, P. 4, and pull flywheel and pinions GB-22 and GB-24, P. 8, off shaft. You may then pull cam and shaft out through oil box.

CAUTION.—Again we advise against attempting repairs on intermittent unit. Do it if you are compelled by circumstances to, but the parts must, in the very nature of things, fit closely. The measurements are in thousandths, or even ten-thousandths of an inch. The projectionist is seldom or never equipped to work to such accuracy. Better get a spare intermittent unit. Costs something, yes, but is worth it.

INSTRUCTION NO. 10.—ADJUSTMENT OF INTERMITTENT TO ELIMINATE LOST MOTION IN SPROCKET. First turn flywheel in direction it normally runs until intermittent sprocket just stops, then give it about an eighth of a turn more. This insures the intermittent being "on the lock," as is necessary for this adjustment. Next loosen screw GB-8, P. 6 and 8, which will be found in hub of oil casing cover carrying intermittent sprocket shaft and bushing. Release this screw by only about one turn. Do not remove it. Next, using small wrench GB-27 (not shown), or some other suitable wrench, turn hexagon nut of bushing (between sprocket and hub) in whichever direction accomplishes the purpose, at the same time "rocking" intermittent sprocket with finger. When the movement is tight enough that you can barely feel a movement of the sprocket it is right. Tighten up screw GB-8 and the job is done.

CAUTION.—Test for lost motion in sprocket should be made immediately after a picture has been projected, because then the parts are expanded by heat of operation to their operating size. The adjustment should be made when projector is cold, at which time if there be just a slight movement of sprocket, when parts are heated by operation they will be quite sufficiently tight. Remember that if you get them too tight undue friction will be set up, which will further increase expansion and friction. Too much lost motion of the intermittent sprocket is bad—too tight an adjustment is still worse.

INSTRUCTION NO. 11.—TO REMOVE UPPER AND LOWER SPROCKETS SF-88, P. 5, it is only necessary to loosen screw and turn stripper plate back out of the way. Then remove screw from sprocket hub and pull sprocket off shaft.

INSTRUCTION NO. 12.—TO REMOVE UPPER OR LOWER SPROCKET IDLERS, remove screw SF-40, P. 2, which is in end of spindle upon which roller turns.

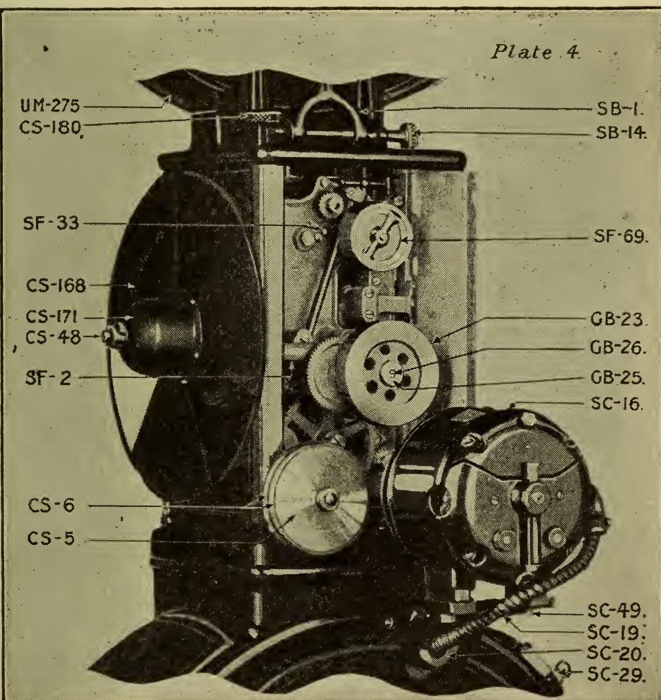


Plate 4, Figure 278.

INSTRUCTION NO. 13.—TO REMOVE UPPER OR LOWER SPROCKET IDLER BRACKETS, SF-30 and SF-31, P. 2, it is only necessary to take out SF-33, P. 4 and 6, which are on opposite side of center wall of frame from the sprockets.

INSTRUCTION NO. 14. — ADJUSTING SPROCKET IDLERS. See general Instruction No. 12, and study same·

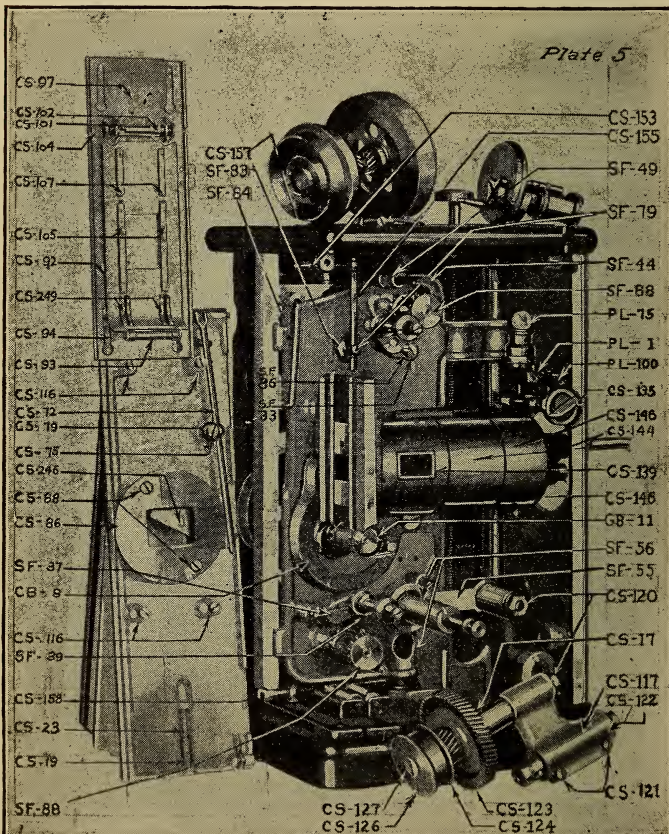


Plate 5, Figure 279.

To adjust upper or lower sprocket idlers loosen screw SF-33, P. 5, slightly and, using screwdriver, turn eccentric SF-86, P. 5, until proper adjustment according to general Instruction No. 12 is obtained, whereupon retighten holding screw.

INSTRUCTION NO. 15.—TO REMOVE FILM TRACKS, SF-58 and SF-59, P. 3, first follow Instruction No. 1 and then

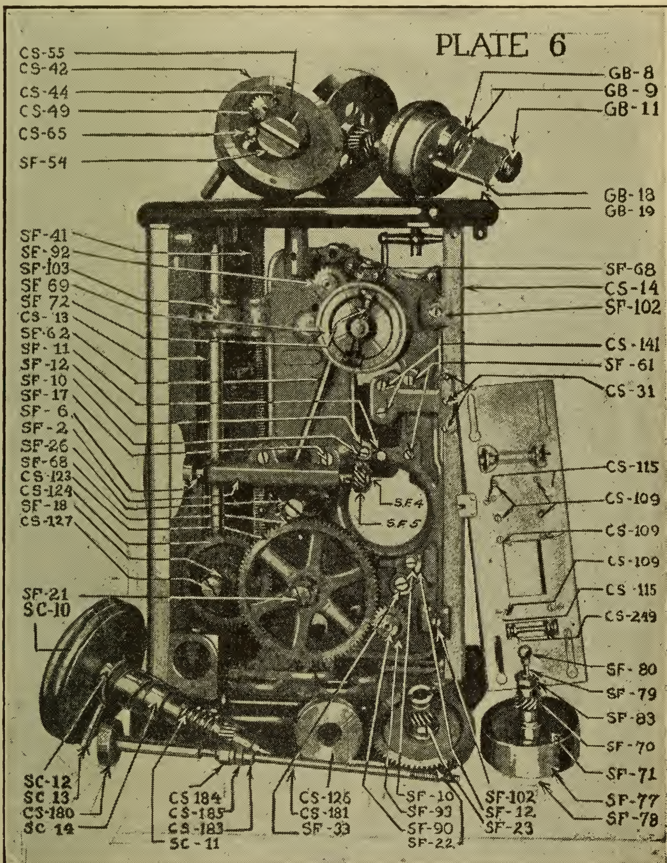


Plate 6, Figure 280.

remove the eight screws SF-60, P. 3, in face of tracks. **This** releases tracks.

INSTRUCTION NO. 16.—TO REMOVE APERTURE PLATE. Follow Instruction No. 15. Removal of film tracks also releases aperture plate, which is located by pin CS-140, P. 3.

INSTRUCTION NO. 17.—TO REMOVE PROJECTION LENS BARREL, consisting of CS-139, CS-144 and CS-146, P. 5, remove two screws, CS-141, P. 6. Remove track support SF-57, P. 2, by taking out two screws, SF-61, P. 6, which will release all parts of lens tube, including focusing screw.

INSTRUCTION NO. 18.—TO FOCUS PICTURE ON SCREEN use focusing screw winged thumb nut CS-135, P. 5, which protrudes from right hand side of mechanism casing near its front edge.

INSTRUCTION NO. 19.—PLACING LENS IN BARREL. At bottom of front end of lens barrel is a clamp screw, CS-148, P. 2, by means of which lens tubes are clamped in lens barrel To insert lens tube loosen this screw and back it off. A sleeve, collar or adapter will be supplied by manufacturer, upon application, to reduce diameter of lens barrel to fit any desired diameter lens tube. Get collar to fit, insert collar and tube. Strike arc, raise fire shutter and project white light (without film) to screen. Move focusing screw CS-135, P. 5, until lens tube is in center of its travel. Shove lens tube in and out until you get edges of light sharply focused on screen, whereupon tighten clamp screw CS-148, P. 5, tight, and the job is done. The picture may then be sharpened on screen by focusing screw when projection is started.

INSTRUCTION NO. 20.—TO REMOVE GRIPPING DISC UNIT SC-100, shown as SC-5, SC-6, P. 3 and 4, remove screw CS-28, P. 3, which engages cam slot in the collar. You may then withdraw the unit.

INSTRUCTION NO. 21.—TO DISASSEMBLE GRIPPING DISC UNIT SC-100, shown as SC-5 and SC-6, P. 3 and 4, follow Instruction No. 20, then drive out taper pin SC-9, P. 3, in hub of disc SC-5, P. 3. This releases both discs and they may be pulled from shaft.

INSTRUCTION NO. 22.—TO RELEASE GRIPPING DISC SPRING SC-11, P. 6, follow Instruction No. 20, after which drive taper pin from pinion on end of shaft. Pull pinion off, which releases spring.

INSTRUCTION NO. 23.—TO REMOVE PINION FROM GRIPPING DISC SHAFT SC-1, P. 3, follow Instruction No. 22.

INSTRUCTION NO. 24.—THROW-OUT LEVER SC-13,P. 6, located just at inner surface of gripping disc, is for the purpose of releasing gripping disc pinion from gear CS-124, P. 6. The gripping discs should be thus released when operating mechanism by means of the crank.

INSTRUCTION NO. 25.—TO REMOVE TOGGLE CASTING, shown, removed from mechanism, as CS-117, P. 5, first follow Instruction No. 20, then loosen two screws CS-121, P. 5, and two screws CS-129, P. 2, and shove out the bronze spindle bushing CS-122, P. 2.

INSTRUCTION NO. 26.—TO DISASSEMBLE TOGGLE UNIT, shown removed from mechanism and posed in lower right-hand corner of P. 5, first follow Instruction No. 25, then remove screw CS-127, P. 5, which will release pulley CS-126, P. 5, and the two gears. To release shaft from casting remove nut CS-120, P. 5.

INSTRUCTION NO. 27.—THE CRANK, SF-48, P. 9, by means of which mechanism is operated by hand, engages with dowel pin SF-20, P. 3, by means of a ratchet. It is held in place on shaft by screw SF-49, in end of shaft—not shown in plates.

INSTRUCTION NO. 28.—Pilot light PL-15, P. 5, is for the purpose of lighting interior of mechanism and for threading in frame. It is automatically lighted by opening the right hand mechanism casing door. The switch is located in the fibre base of the lamp, which is operated by means of a two-cell dry battery located on rear wall of upper magazine. When right hand casing door is closed lamp is automatically switched off.

INSTRUCTION NO. 29.—TO REMOVE THE AUTOMATIC FIRE SHUTTER GOVERNOR, SF-69,P.4, follow instruction No. 1, which removes film gate. Next remove governor lever CS-153,P.5, by removing slotted nut CS-157, P.5, located on top of frame casting, behind magazine. Next remove the two hexagon nuts, SF-82,P.3, in end of shaft, which passes through governor unit, and remove hexagon nut SF-83,P.5, whereupon entire governor unit will be released.

INSTRUCTION NO. 30.—TO DISASSEMBLE AUTOMATIC FIRE SHUTTER GOVERNOR—First follow Instruction No. 29, then remove two screws, which hold casing SF-77, lower right corner, P. 6, to governor unit, and take casing off. To release governor weights, inside of unit, it is only necessary to drive out the hinge pins, in either direction, they being non-taper pins.

INSTRUCTION NO. 31.—TO REMOVE REVOLVING SHUTTER SUPPORTING UNIT, shown posed on top of mechanism casing, CS-44, P. 6, take out the four screws separately numbered CS-43, P. 3, which releases the entire unit.

INSTRUCTION NO. 32.—TO DISASSEMBLE REVOLVING SHUTTER UNIT, shown removed from mechanism and posed in two positions, CS-44, in P. 3 and P. 6, first follow Instruction No. 31. Next loosen screw CS-52, P. 3, in collar of universal shutter mount, which will release both the mount

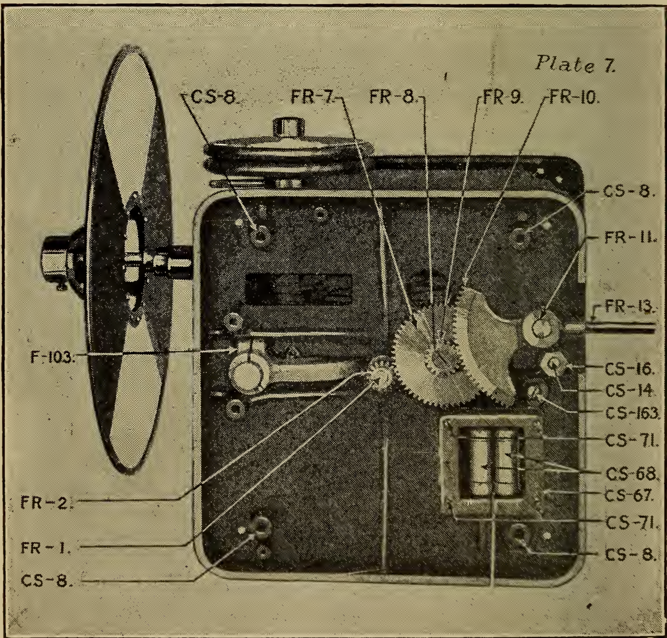


Plate 7, Figure 281.

and the shutter shaft. To release shutter drive shaft, **CS-53**, P. 3, loosen screw in collar CS-53. To release shutter shaft and shutter driving shaft bushings loosen the set screw which holds each, first, of course, having removed the shafts themselves. To remove pinion CS-49, P. 6, and pinion it meshes with, first remove the shafts themselves from their bushings, and then drive out the taper pins by means of

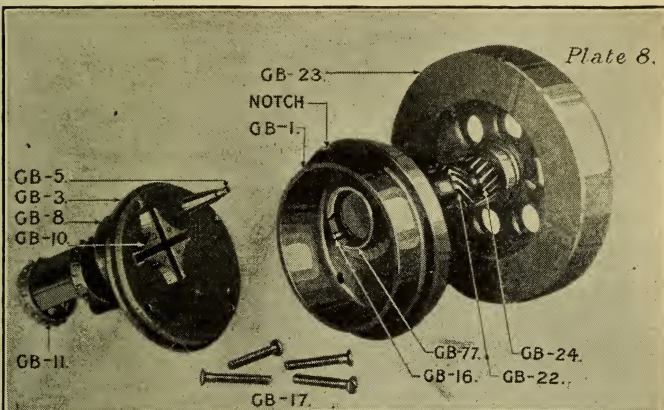


Plate 8, Figure 282.

which gears are locked to shaft. Disc CS-55, P. 6, may be removed by driving out the taper pin which holds it.

INSTRUCTION NO. 33.—TO REMOVE SHUTTER DRIVE SHAFT BEARING SF-2, P. 4 and 6, first follow Instruction No. 6 and then remove double gear SF-22 and 23, by taking out screw SF-26, P. 6. Next remove the two screws SF-17, P. 6 (arrow only points to one. Other is ¼ inch to left) and the bearing will be released.

Disc SF-6 and Pinion SF-5 are secured to shaft by taper pins. The bronze bearings in which the shaft revolves are driven in at either end. They are not intended to be replaced. When worn it is necessary that a new bearing complete be ordered and installed.

INSTRUCTION NO. 34.—TO REMOVE DIAGONAL SHAFT SF-62, P. 6, remove the two screws (SF-68) which hold the bearing at either end of shaft, which releases both bearings and shaft.

INSTRUCTION NO. 35.—ADJUSTING, SETTING OR TIMING REVOLVING SHUTTER. First carefully study general Instruction No. 22 until you thoroughly understand the principles involved. In the Motiograph DeLuxe Model a universal mount is used in order to enable the removal and replacement of the revolving shutter without readjustment, or re-setting. The small hexagon nut on front end of hexagon collar is used to clamp the disc carrying pin CS-64, lower right corner, P. 3, in position to secure rough adjustment of shutter, the finer adjustment being secured by turning knob CS-180, P. 4, at top left-hand corner of mechanism. The knurled knob at top of rod CS-181, P. 3, is held to rod by a set screw which engages a flat spot on rod, and collar CS-183, P. 3, is held to shaft by set screw, which also engages with flat spot on shaft. End-shake, or movement of rod is prevented by use of adjusting nut CS-184, P. 3, and check nut CS-185, P. 3.

INSTRUCTION NO. 36.—TO ATTACH REVOLVING SHUTTER TO ITS SHAFT, dowel pin CS-64, P. 3, must enter hole in collar of shutter, and the shutter be clamped in place by screw CS-172, P. 3, in hub of shutter. The revolving shutter blade is carried by a sort of cradle, the hub of which is CS-171, P. 3. This is an excellent arrangement in that it permits of the blade being placed right up against the front plate of the mechanism—as close to lens as it is possible to get it—in the case of very short focal length projection lens, whereas when a very long E. F. projection lens is used the shutter may be reversed and actually made to be some distance beyond the end of the shutter shaft. Under some conditions this is a very valuable feature, in that it permits of a virtual lengthening of the shutter shaft.

INSTRUCTION NO. 37.—TO RELEASE SHUTTER ADJUSTING SHAFT CS-181, P. 3, from shutter supporting unit, remove screw from opposite end of stud CS-65, P. 3, and to release shaft CS-181, P. 3, from frame of mechanism casing loosen screw which locks knob CS-180, P. 4, to shaft, having first released shaft from shutter supporting unit.

INSTRUCTION NO. 38.—TO REMOVE SLIDING MECHANISM FRAME, which is the vertical sliding frame which carries most of the gearing and other parts, first follow Instruction No. 17, then take off the front plate by removing two screws, one at either front top corner of mechanism casing, and two screws from the inside of lower corners of the front plate (front plate is plate which is next screen), which screw into the base; also a large screw in the middle front of top plate. This latter screw engages the large round rod on the frame slides. Next remove lens barrel bracket by taking out three screws CS-31, P. 6, and two screws, not shown, which secure other end of bracket to round slide rod CS-13, P. 6.

INSTRUCTION NO. 39.—TO REMOVE THE FRAMING PARTS, which are located on under side of base of mechanism, remove gear segment FR-10, P. 7, by driving out the taper pin which secures gear segment to stud FR-11, P. 7. Having done this you may then remove double gear FR-7, FR-8, P. 7, by taking out screw FR-9, in center of stud on which gear rides. Pinion FR-2, P. 7, is removed by driving out taper pin which secures it to framing screw FR-I, P. 7. Framing handle FR-13, P. 7, is removed by screwing it out, using a plier if necessary, lining its jaws with paper to prevent scarring handle.

INSTRUCTION NO. 40.—BALANCING AND TENSION OF MECHANISM FRAME. The mechanism frame is balanced by spring SF-41, P. 6. The tension of this spring is adjusted by a slotted screw nut located back of top magazine and about two inches from front of mechanism frame. The tension of the sliding frame is regulated by two screws, SF-103, P. 6 and 7, which clamp the sliding frame to the round slide rod, CS-13, P. 7. The rear of the sliding frame is guided by the square slide rod, CS-14, P. 3, and 6 and the guides are adjusted to the square rods by two screws, SF-106, P. 6, one near top and one near bottom. These screws should be only tight enough to prevent any vibration or shake of sliding frame and the tension (ease of sliding) should be regulated by screws SF-103, P. 6, which latter should be set just tight enough to prevent the sliding frame from "crawling" when the projector is in operation. If too loose the frame will crawl. If too tight the framing handle will work too hard.

INSTRUCTION NO. 41—THE SPEED CONTROL. The driving disc is mounted directly on the motor shaft, and is held in place by a set screw. The speed of projector mechanism is altered by rocking the motor on the shaft of the motor support, SC-20, P. 9. Attached to shaft of motor support, SC-20, P. 9, is an arm, SC-22, which is held in place by two screws, SC-25, P. 9. On the end of the arm is a roller, SC-23, P. 9, held in place by a screw in center of roller bearing. This roller engages with a cam, SC-34, P. 9, attached to shaft SC-30, P. 9, by set screw SC-35, P. 9. Handle SC-29, P. 9, is the speed control lever, or handle. SC-19, P. 4, is an armored electric circuit extending to motor through motor support bracket SC-20, P. 9.

INSTRUCTION NO. 42—LUBRICATION. See general Instruction No. 1, in addition to which the manufacturer advises that they furnish a special heavy oil designed for use in the oil well of the intermittent movement, and a special grease gun is supplied with each Motiograph installation with which to inject the oil. The opening for injecting the oil is about three-quarters of an inch to the right of the locating notch in the top of the box, or oil well, on the left side of the sliding frame. "Geneva Lubricating Grease" is supplied in either three-ounce or one-pound cans.

FOR SLIDING DISC SHUTTER CONNECTION a

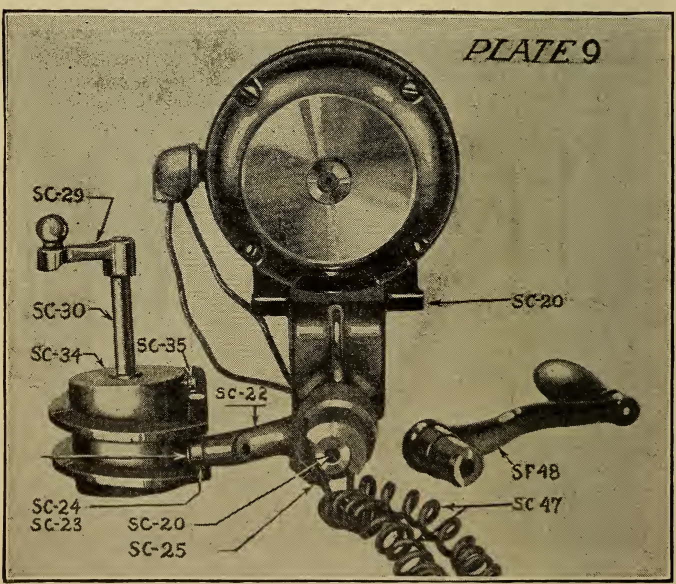


Plate 9, Figure 283.

heavier grease, called "Disc Grease," should be used. It may be had of the projector manufacturer in either three-ounce or one-pound cans.

We recommend that you order these lubricants and use them for the purposes named.

THE SPEED CONTROL DISCS should be given a drop of oil occasionally.

THE INNER END OF SPEED CONTROL SHAFT is lubricated by an oil tube located about the center of the lower front part of the mechanism casing, on the outside. It is of vital importance that you do not overlook this oiling place. There is an oil hole in the pinion sleeve back of the governor. Do not overlook it. The hole in center of take-up pulley screw CS-127, P. 6, is an oil hole.

NOTE.—The Enterprise Optical Company, manufacturers of the Motiograph, issue an instruction book, which will be sent you free upon application.

INSTRUCTION NO. 43—TO ADJUST PROJECTOR FOR ANGULAR PROJECTION—Loosen two clamp bolts, P. S. 252, P. 10, and turn hand screw P. S. 250 to the right or to

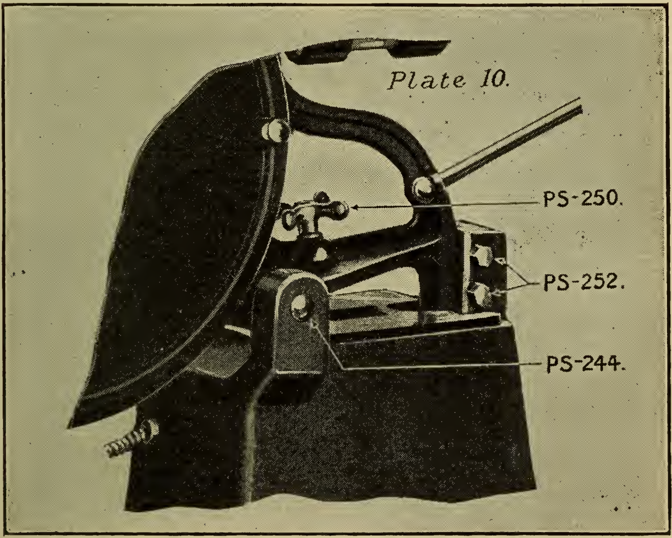


Plate 10, Figure 284.

the left to raise or lower rear end of projector until desired angle is had, after which tighten clamp bolts P. S. 252.

CAUTION.—Never attempt to change the projector angle by means of hand screw P. S. 250 until the clamp bolts have been loosened.

PARTS FOR MOTIOGRAPH.—De Luxe Model.

NOTE.—Order by number and description, but do not omit the number. The numbers are the manufacturers stock number.

Plate	No.	Description.
—	CS-1	Base.
—	CS-2	Top.
—	CS-3	Front plate.
2	CS-4	Film gate.
4	CS-5	Left side rear door.
4	CS-6	Left side door.
—	CS-7	Right side door.
7	CS-8	Screw to hold mechanism to lower magazine.
—	CS-9	Hinge stud for film gate.
—	CS-10	Screw for hinge stud.
—	CS-11	Stud to guide lens barrel.
—	CS-12	Nut for stud CS-11.
6	CS-13	Round tie rod.
3-6-7	CS-14	Square tie rod.
—	CS-15	Screw for round and square tie rod.
7	CS-16	Nut for square tie rod.
5	CS-17	Door latch pin (short).
—	CS-18	Door latch pin (long).
5	CS-19	Gate Latch pin.
2	CS-20	Gate hinge knob (short).
—	CS-21	Door latch knob (long).
—	CS-22	Door latch spring (short).
5	CS-23	Door latch spring (long)
—	CS-24	Door hinge pin.
—	CS-25	Screw in gate for stop rod.
—	CS-26	Screw to clamp front plate to tie rod, 7-8x8x32.
—	CS-27	Screw to hold front plate to top and bottom.
3	CS-28	Screw to retain motor drive bushing.
—	CS-29	Cross bracket.
—	CS-30	Bracket screw for round rod.
6	CS-31	Bracket screw for square rod.
—	CS-32	Stop in for intermittent tension shoe.
2	CS-33	Latch for film gate.
—	CS-34	Collar for gate latch No. 33.
—	CS-35	Screw for gate latch No. 33.
—	CS-36	Glass for right side door (top).
—	CS-37	Glass for right side door (left side).
—	CS-38	Glass for right side door (right side).
—	CS-39	Glass for left side door.
—	CS-40	Retainer clip for glass.
—	CS-41	Screw for retainer clip.
3-6	CS-42	Retainer ring for shutter bracket.
3	CS-43	Screw to hold retainer ring.
6-3	CS-44	Shutter bracket.
3	CS-45	Screw to retain shutter bracket bushing.
—	CS-46	Bushing for shutter shaft.
—	CS-47	Bushing for shutter shaft drive.
3-4	CS-48	Shaft for shutter.
6-3	CS-49	Pinion on shutter shaft
—	CS-50	Taper pin for shutter pinions.
—	CS-51	Collar on shutter shaft Hex.
3	CS-52	Screw in shutter shaft collars.
3	CS-53	Shaft for shutter drive.
—	CS-54	Pinion on shutter drive shaft.
3-6	CS-55	Disc on shutter drive shaft.
—	CS-56	Taper pin in discs.
3	CS-57	Collar on shutter drive shaft.
—	CS-58	Dowel screw for front plate.
—	CS-59	Screw for shutter bracket friction.
—	CS-60	Plug for shutter bracket friction.
—	CS-62	Flange for shutter shaft collar.
—	CS-63	Hex. nut for shutter shaft collar.
3	CS-64	Pin to locate shutter.
3-6	CS-65	Stud for shutter adjusting rod in bracket.
—	CS-66	Screw to retain shutter adj. rod stud.
7	CS-67	Fire trap.
7	CS-68	Roller for fire trap.
—	CS-69	Bushing for fire trap roller.
—	CS-70	Shaft for fire trap roller
7	CS-71	Screw to hold fire trap to base.
5	CS-72	Rack lever for fire shutter.
—	CS-73	Rack for fire shutter.

Plate	No.	Description.
—	CS-74	Rivet for rack and hook on door stop.
5	CS-75	Bearing for rack lever.
—	CS-76	Rivet for rack lever bearing.
2	CS-77	Stud to operate fire shutter.
—	CS-78	Washer for bearing screw.
5	CS-79	Screw in rack lever bearing.
—	CS-80	Fire shutter plate, gear side.
—	CS-81	Pinion on fire shutter.
—	CS-82	Shaft for fire shutter.
—	CS-83	Fire shutter plate, collar side.
—	CS-84	Collar on fire shutter.
—	CS-85	Rivet for fire shutter.
5	CS-86	Metal heat shield in side gate.
—	CS-87	Stop stud for fire shutter.
5	CS-88	Screw to hold heat shield.
—	CS-89	Stop Stud for fire shutter in door.
—	CS-90	Heat shield asbestos.
—	CS-91	Screw for heat shield.
5	CS-92	Film tension plate.
5	CS-93	Roller on tension plate.
5	CS-94	Shaft for roller.
—	CS-95	Spring for intermittent sprocket shoe.
5	CS-97	Gate slide.
—	CS-98	Clip for gate slide.
—	CS-99	Rivet for clip.
—	CS-100	Locating stud in gate slide.
5	CS-101	Film guide roll, spring end.
5	CS-102	Film guide roll, plain end.
—	CS-103	Spring for guide roll.
5	CS-104	Shaft for guide roll.
5	CS-105	Tension shoe (long).
—	CS-106	Spring for tension shoe (long).
5	CS-107	Tension shoe (short).
—	CS-108	Spring for tension shoe (short).
6	CS-109	Screw for tension shoe.
—	CS-110	Tension shoe for intermittent sprocket, outside
—	CS-111	Spacing collar for tension shoe.
—	CS-112	Tension shoe for intermittent sprocket, inside.
—	CS-113	Spacing rod for tension shoe.
—	CS-114	Collar between gate slide and tension plate.
6	CS-115	Screw to hold tension plate to gate slide.
5	CS-116	Screw to hold gate slide to gate.
5	CS-117	Toggle casting.
—	CS-118	Toggle gear shaft.
—	CS-119	Washer on toggle gear shaft.
5	CS-120	Nut on toggle gear shaft
5	CS-121	Screw to clamp toggle casting.
2-5	CS-122	Bushing in toggle casting.
5-6	CS-123	Gear on toggle shaft, steel.
5	CS-124	Pinion on toggle shaft, steel.
—	CS-125	Key pin in pinion.
5-6	CS-126	Take-up pulley.
5-6	CS-127	Screw in toggle gear shaft.
2	CS-129	Screw in tension plug.
—	CS-130	Lens focusing bracket.
—	CS-131	Dowel pin for focusing bracket.
—	CS-132	Shaft for focusing bracket.
—	CS-133	Pinion in focusing bracket.
—	CS-134	Pin to hold pinion No. 133 to shaft.
5	CS-135	Thumb knob for focusing bracket.
—	CS-136	Wing for knob No. 135.
—	CS-137	Screw to hold focusing knob to shaft.
—	CS-138	Screw to hold focusing bracket.
5	CS-139	Lens barrel, rear.
3	CS-140	Stud for aperture plate.
6	CS-141	Screw to hold lens barrel to bracket.
—	CS-142	Glass in lens barrel.
—	CS-143	Retainer ring for lens barrel glass.
5	CS-144	Tube between lens barrels.
—	CS-145	Screw to hold tube to barrel.
2-5	CS-146	Lens barrel front.
—	CS-147	Bushing in lens barrel.
2	CS-148	Screw to clamp lens barrel.
—	CS-149	Lens adapter.
—	CS-152	Lens focusing screw rod.
5	CS-153	Governor lever.
—	CS-154	Bushing for lever No. CS-153.
5	CS-155	Rod for lever No. CS-153.
—	CS-156	Screw shaft for lever No. CS-153.
5	CS-157	Nut to hold lever to top.
2-3-5	CS-158	Stop rod for film gate.
—	CS-159	Hook in end of stop rod.
3	CS-160	Friction stud for stop rod.
—	CS-161	Ball in friction stud.
—	CS-162	Spring in friction stud.
7	CS-163	Screw in friction stud.
2	CS-164	Cover for crank opening.
—	CS-165	Dowel pin for cover No. CS-164.
3	CS-166	Screw for cover No. CS-164.
—	CS-167	Shutter, 3 blade.
3-4	CS-168	Shutter, 2 blade.
3	CS-169	Shutter hub.
3	CS-170	Screw to hold shutter to hub.
3-4	CS-171	Collar for shutter hub.

Plate	No.	Description.
3	CS-172	Set screw for shutter collar.
—	CS-173	Screw to locate shutter hub.
—	CS-174	Light shield.
—	CS-175	Glass retainer strip for shield.
—	CS-176	Rivet for glass retainer.
—	CS-177	Clip to hold shield to gate.
—	CS-178	Screw to hold shield to gate.
—	CS-179	Ruby glass for shield.
4-6	CS-180	Thumb knob for set shutter.
3-6	CS-181	Screw rod to set shutter.
3	CS-182	Screw to hold knob to screw rod.
3-6	CS-183	Collar for shutter seting screw rod.
3-6	CS-184	Thrust sleeve.
3-6	CS-185	Lock nut for thrust sleeve.
—	CS-186	Oil tube for drive shaft.
—	CS-187	Screw to hold oil tube.
—	CS-188	Collar for int. spkt. shoe spring.
—	CS-189	Washer for int. spkt. shoe spring.
—	CS-190	Screw to hold front to base vrt.
5	CS-246	Fire shutter, complete.
2	CS-247	Fire trap, complete.
2	CS-248	Light shield, complete.
5-6	CS-249	Inter. sprocket shoe, complete.
—	CS-250	2 wing shutter, complete.
—	CS-251	3 wing shutter, complete.
—	SF-1	Sliding frame.
4-6	SF-2	Bearing shutter drive shaft.
—	SF-3	Bushing for shutter drive shaft.
6	SF-4	Shutter drive shaft.
6	SF-5	Pinion on shutter drive shaft.
6	SF-6	Disc on shutter drive shaft.
—	SF-7	Taper pin for pinion and disc.
—	SF-8	Bushing for upper and lower sprocket shaft.
—	SF-9	Bushing for crank shaft.
6	SF-10	Screw to clamp geneva box.
6	SF-11	Stud to locate geneva box.
6	SF-12	Clamp for geneva box.
—	SF-13	Clamp pin for geneva box.
—	SF-14	Screw for balance spring.
—	SF-15	Key pin for gears.
6	SF-17	Screw for shutter drive bearing.
6	SF-18	Main gear. steel.
—	SF-19	Crank shaft.
3	SF-20	Pin in crank shaft.
3-6	SF-21	Thumb screw in crank shaft.
6	SF-22	Double gear, steel.
6	SF-23	Pinion on double gear, steel.
—	SF-24	Pinion to drive angle shaft.
—	SF-25	Double gear shaft.
6	SF-26	Screw to retain double gear on shaft.
2	SF-27	Screw to retain shaft 25 in frame.
3	SF-28	Aperture plate.
2	SF-30	Roller bracket, upper.
2	SF-31	Roller bracket, lower.
—	SF-32	Shaft for roller brackets.
2-4-5-6	SF-33	Screw in roller bracket shaft.
—	SF-34	Taper pin to hold bracket to shaft.
—	SF-35	Screw to clamp roller shaft.
—	SF-36	Stud for roller bracket spring.
2-5	SF-37	Spring for roller brackets.
—	SF-38	Film roller shaft.
2-5	SF-39	Film roller.
2	SF-40	Thumb screw for roller shaft.
6	SF-41	Balance spring.
—	SF-42	Screw bushing in end of spring.
—	SF-43	Screw for adjusting spring.
5	SF-44	Stripper plate.
—	SF-45	Shaft for stripper plate.
—	SF-46	Screw for stripper plate.
—	SF-47	Screw for stripper plate shaft.
9	SF-48	Crank.
5	SF-49	Retaining screw for crank.
—	SF-50	Stud for crank handle.
—	SF-51	Handle for crank.
—	SF-52	Washer for crank handle.
—	SF-53	Screw for crank handle.
6	SF-54	Floating disc.
5	SF-55	Link for toggle.
5	SF-56	Screw for toggle link.
2	SF-57	Track support.
3	SF-58	Track, right side.
3	SF-59	Track, left side.
3	SF-60	Screws to tracks.
6	SF-61	Screw to hold track support to frame.
6	SF-62	Diagonal shaft.
—	SF-63	Pinion governor drive.
—	SF-64	Pinion upper sprocket drive.
—	SF-65	Taper pin for diagonal shaft pinions.
—	SF-66	Bushing for diagonal shaft.
—	SF-67	Cap for diagonal shaft bushing.
6	SF-68	Screw for cap No. SF-67.
4-6	SF-69	Governor support collar.
3-6	SF-70	Pinion on governor.
6	SF-71	Governor weight.
6	SF-72	Ball stud for governor weight.
—	SF-73	Governor shaft in frame.
—	SF-74	Governor weight collar.
—	SF-75	Pivot pin for governor weight.

Plate.	No.	Description.
—	SF-76	Spring for governor weight.
6	SF-77	Governor case.
6	SF-78	Screw in governor case.
5-6	SF-79	Shaft in governor wght. collar.
6	SF-80	Ball on end of shaft No. SF-79.
—	SF-81	Rivet to hold ball on shaft No. SF-79.
3	SF-82	Nuts for collar shaft No. SF-79.
5-6	SF-83	Nuts to hold governor shaft in frame.
3-5	SF-84	Link for gate slide.
—	SF-85	Nut for gate slide link.
5	SF-86	Ecc. stop for roller bracket.
—	SF-87	Lock stud for eccentric stop.
5	SF-88	Feed and take - up sprocket.
—	SF-89	Shaft for feed sprocket.
6	SF-90	Shaft for take-up sprocket.
—	SF-91	Screw for feed and take-up sprocket.
6	SF-92	Feed sprocket pinion.
3-6	SF-93	Take-up sprocket pinion.
3	SF-94	Screw for sprocket pinions.
—	SF-95	Film footage counter bracket.
—	SF-97	Screw to hold counter to bracket.
—	SF-98	Pinion on counter.
3	SF-99	Counter pinion main shaft.
—	SF-100	Screw to hold counter pinion on shaft.
—	SF-101	Screw to hold counter bracket to frame.
6	SF-102	Friction screw in frame for square rod.
6-7	SF-103	Friction screw in frame for round rod.

UPPER MAGAZINE.

Plate.	No.	Description.
—	UM-200	Governor, complete.
	UM-201	Spider for upper magazine.
2	UM-202	Screew to hold spider to machine.
	UM-203	Magazine bottom.
	UM-204	Magazine band.
	UM-205	Rivets for magazine band.
	UM-206	Magazine door.
	UM-207	Hinge on body.
	UM-208	Hinge on cover.
	UM-209	Hinge pin.
	UM-210	Screw in door hinge.
	UM-211	Nut for hinge screws.
	UM-212	Screw for body hinge.
	UM-213	Wired glass circle.
	UM-214	Frame for glass circle.
	UM-215	Screw for frame.
	UM-216	Nut for frame.
	UM-217	Reel shaft.
	UM-218	Collar on reel shaft.
	UM-219	Staple on reel shaft.
	UM-220	Plunger for reel shaft.
	UM-221	Spring for reel shaft plunger.
	UM-222	End of reel shaft.
	UM-223	Pin in end of reel shaft.
	UM-224	Thumb nut on reel shaft.
	UM-225	Screw to retain thumb nut.
	UM-226	Brake spring.
	UM-227	Brake pad.
	UM-228	Brake pad rivets.
	UM-229	Brake spring screw.
	UM-230	Brake spring washer.
	UM-231	Door knob.
	UM-232	Stud for door latch.
	UM-233	Door latch.
	UM-234	Spring for door latch.
	UM-235	Collar for door latch.
	UM-236	Screw for door latch collar.
	UM-237	Door catch.
	UM-238	Screw for door catch.
	UM-239	Screw for door catch.
	UM-240	Nut for door catch screw.
	UM-241	Fire trap roller.
	UM-242	Bushing for fire trap roller.
	UM-243	Shaft for fire trap roller.
	UM-244	Screw to hold magazine to spider.
	UM-245	Felt washers between magazine and spider.
4	UM-275	Upper magazine complete, less spider.

FRAMER.

Plate.	No.	Description.
2-7	FR-1	Framer screw.
7	FR-2	Pinion on framer screw.
—	FR-3	Taper pin for framer pinion.
—	FR-4	Yoke for framer screw.
—	FR-5	Screw for framer yoke.
—	FR-6	Dowel pins for yoke.
7	FR-7	Gear for framer.
7	FR-8	Pinion on framer gear No. FR-7.
7	FR-9	Screw shaft for framer gear.
7	FR-10	Framer gear segment.
7	FR-11	Stud for segment No. 10.
—	FR-12	Taper pin for segment No. 10.
3-7	FR-13	Framer handle.

TAKE UP.

Plate.	No.	Description.
—	TU-1	Bracket for take - up spindle.
—	TU-2	Screw to hold bracket to magazine.
—	TU-3	Shaft for take-up.
—	TU-4	Collar on take-up shaft.
—	TU-5	Staple on take-up shaft.
—	TU-6	Spring in take-up shaft.
—	TU-7	Plunger in take-up shaft.
—	TU-8	End of reel shaft.
—	TU-9	Pin to hold end to shaft.
—	TU-10	Ball bearing cone.
—	TU-11	Screw for ball bearing cone.
—	TU-12	Housing for ball bearing
—	TU-13	Steel ball.

Plate.	No.	Description.
—	TU-14	Fibre washer.
—	TU-15	Idler pulley arm.
—	TU-16	Idler pulley.
—	TU-17	Screw shaft for idler pulley.
—	TU-18	Take-up pulley.
—	TU-19	Nut to hold pulley to shaft.
—	TU-20	Idler adjusting screw rod.
—	TU-21	Screw to hold adjusting rod to arm.
—	TU-22	Thumb knob for adjusting screw rod.
—	TU-23	Stem for thumb knob.
—	TU-24	Nut to hold housing to bracket.
—	TU-25	Take-up belt.
—	TU-26	Lacing for take-up belt.

PILOT LAMP.

5	PL-1	Fibre bracket for lamp.
—	PL-2	Contact for lamp switch (short).
—	PL-3	Contact for lamp switch (long).
—	PL-4	Fibre piece for contact.
—	PL-5	Rivets for fibre piece.
—	PL-6	Screw to hold contact to bracket.
—	PL-7	Top plate for lamp bracket.
—	PL-8	Bottom plate for lamp bracket.
—	PL-9	Screw to hold plate on bracket.
—	PL-10	Nut to hold plate on bracket.
—	PL-11	Fibre contact cover.
—	PL-12	Screw to hold contact cover.
—	PL-13	Lamp socket.
—	PL-14	Screw to hold lamp socket.
5	PL-15	Pilot lamp.
—	PL-16	Lamp cord.
—	PL-17	Bushing between lamp bracket.
—	PL-18	Screw to hold lamp bracket.
—	PL-19	Battery box.
—	PL-20	Top fibre piece for battery box.
—	PL-21	Bottom fibre piece for battery box.
—	PL-22	Rivet for top and bottom fibre.
—	PL-23	Cover catch pins.
—	PL-24	Back fibre piece for battery box.
—	PL-25	Cover for battery box.
—	PL-26	Knob for cover.
—	PL-27	Bushing between box and magazine.
—	PL-28	Screw to hold box to magazine.
—	PL-29	Nut to hold box to magazine.
—	PL-30	Clamp to hold wire to magazine.
—	PL-31	Screw to hold wire to magazine.
5	PL-100	Lamp bracket complete.

GENEVA BOX, OR INTERMITTENT MOVEMENT.

Plate	No.	Description.
8	GB-1	Inter. box.
—	GB-2	Bushing for cam shaft.
8	GB-3	Cover for geneva box.
—	GB-4	Stud for geneva box cover.
8	GB-5	Dowel pin to locate cover on box.
—	GB-6	Threaded bushing to clamp eccentric.
—	GB-7	Bushing to clamp eccentric.
5-6-8	GB-8	Screw for eccentric clamp bushing.
6	GB-9	Ecc. bushing.
8	GB-10	Geneva star.
5-6-8	GB-11	Intermittent sprocket.
—	GB-12	Taper pin in sprocket.
—	GB-13	Cam shaft.
—	GB-14	Cam.
—	GB-15	Taper pin to hold cam on shaft.
8	GB-16	Cam pin.
8	GB-17	Screw to hold cover to box.
6	GB-18	Stripper plate.
6	GB-19	Rod for stripper plate.
—	GB-20	Screw to hold stripper on rod.
—	GB-21	Screw to clamp stripper rod.
8	GB-22	Shutter drive pinion on geneva box.
4-8	GB-23	Fly wheel.
8	GB-24	Pinion on fly wheel.
4	GB-25	Key washer for fly wheel.
4	GB-26	Screw to hold fly wheel.
—	GB-27	Wrench for eccentric bushing.
—	GB-75	Geneva box, complete.
—	GB-76	Cover for geneva box with stud.
—	GB-77	Cam and shaft.

STEREOPTICON BRACKET.

4	SB-1	Stereo arm.
—	SB-2	Stereo lens ring.
—	SB-3	Stereo lens retainer ring.
—	SB-4	Swivel for lens ring.
—	SB-5	Screw for lens ring swivel.
—	SB-6	Screw to clamp swivel.
—	SB-7	Nut to clamp swivel.
—	SB-8	Screw to clamp lens rod.
—	SB-9	Rod for stereo lens ring.
—	SB-10	Vertical adj. screw for lens arms.
—	SB-11	Lock nut for vertical adj. screws.
—	SB-12	Support for lens arm.
—	SB-13	Nut for lens arm support.
4	SB-14	Focusing screw rod.
—	SB-15	Knob for focusing screw rod.
—	SB-16	Pin in knob No. 15.
—	SB-17	Screw in end of focusing rod.

SPEED CONTROL.

3	SC-1	Motor drive shaft.

Plate.	No.	Description.
—	SC-2	Pin in motor drive shaft.
—	SC-3	Pinion on motor drive shaft.
—	SC-4	Taper pin to hold pinion to shaft.
3	SC-5	Outer gripping disc.
3	SC-6	Fibre for gripping disc.
—	SC-7	Plate to hold fibre to disc.
—	SC-8	Screw to hold fibre to disc.
3	SC-9	Taper pin to hold gripping disc to shaft.
6	SC-10	Inner gripping disc.
6	SC-11	Spring to compress gripping discs.
6	SC-12	Spiral groove bushing.
6	SC-13	Lever pin for grooved bushing.
6	SC-14	Collar on inner disc hub.
3	SC-15	Screw in collar No. 14.
—	SC-16	Motor.
—	SC-17	Conduit elbow.
—	SC-18	Screw for conduit elbow.
4	SC-19	Conduit.
4-9	SC-20	Motor support, for 110 volt motor.
—	SC-21	Motor support, for 220 volt motor.
9	SC-22	Arm for motor support.
9	SC-23	Roller for motor support arm.
9	SC-24	Screw for motor support arm roller.
9	SC-25	Screw to clamp support arm to support.
—	SC-26	Pivot screw for support arm.
—	SC-27	Disc on motor.
—	SC-28	Screw for motor disc.
4-9	SC-29	Control lever.
9	SC-30	Control rod.
—	SC-31	Pin to hold control lever to rod.
—	SC-32	Dial plate.
—	SC-33	Screw for dial plate.
9	SC-34	Cam to control motor.
9	SC-35	Screw to hold cam to control rod.
—	SC-36	Conduit clamp.
—	SC-37	Screw to hold conduit to mag. wall.
—	SC-38	Nut to hold conduit to mag. wall.
—	SC-39	Screw to hold conduit to motor support.
—	SC-40	Motor switch.
—	SC-41	Push button for switch.
—	SC-42	Bushing for push button in mag.
—	SC-43	Spacing collar for switch (short).
—	SC-44	Spacing collar for switch (long).
—	SC-45	Screw to hold switch to mag.
—	SC-46	Nut to hold switch to mag.
9	SC-47	Wire cord from main to switch.
—	SC-48	Conduit from main to switch.
4	SC-49	Screw to hold motor to support.
—	SC-100	Gripping disc unit.

KNOWLEDGE IS POWER.

The Baird Projector

THE Baird projector was the first distinctly heavily built type of motion picture projector. Its lamphouse is of ample dimensions and its arc lamp is well designed and well made. The mechanism is of the "inclosed" type, the casing having been removed to show the mechanism in Figs. 286, 287 and 288. Fig. 285 supplies a general view of the projector, as well as all necessary dimensional measurements. The projector may be tilted to a 25 degree angle.

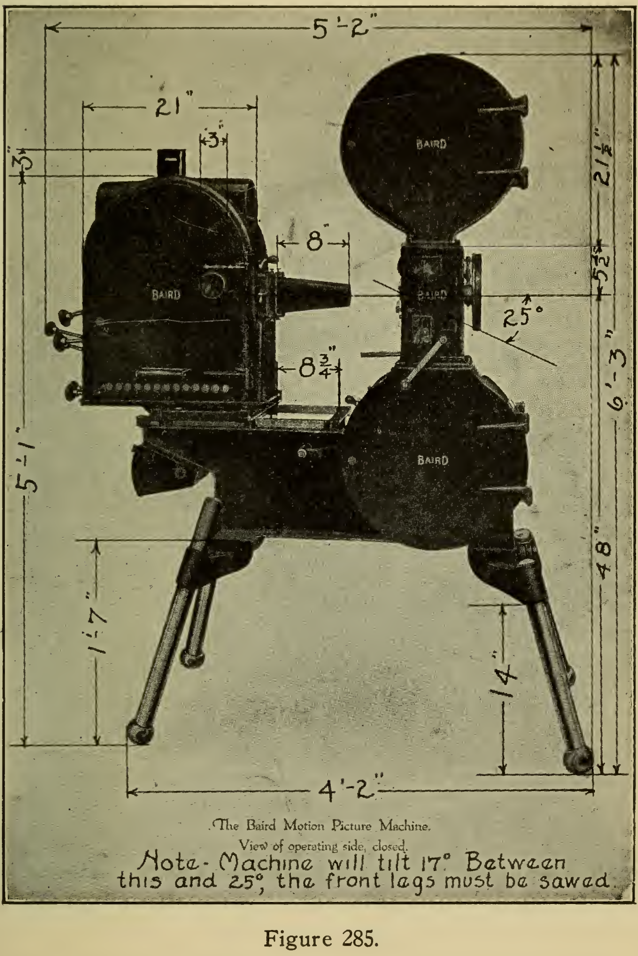
INSTRUCTION NO. 1.—To remove revolving shutter, 310P, P. 2, complete with its housing and lens tube 318P, P. 3, proceed as follows: Loosen screw 867P, P. 1, and pull the entire shutter, including its casing, straight out away from the machine. Shaft 312P, P. 2, which is hexagonal in shape, is not attached rigidly to the mechanism, but telescopes into the hexagonal hole in shaft 130P, P. 3.

INSTRUCTION 2.—In order to remove the casing of the projector mechanism, first follow Instruction No. 1, and then remove seven screws which secure the front casing to mechanism. This releases the entire casing from the mechanism, including two doors but not including the gate.

INSTRUCTION NO. 3.—To remove the cover for the shutter casing (not shown in the cut) grasp the cover and turn ¼ inch to the left. It will then be disengaged and can be pulled off.

INSTRUCTION NO. 4.—In order to remove shutter 310P, P. 2, drive out the taper pin in the hub and pull it off the shaft.

INSTRUCTION NO. 5.—To remove shutter shaft 312P, P. 2 and 3, follow Instructions Nos. 3 and 4, which will disclose a steel ring containing in its face three machine screws. Take out these screws and pull the ring off, which will release shutter shaft 312P, P. 2 and 3, and its ball bearing. Should it become necessary at any time to replace this ball bearing, you must order the shaft and bearing complete from the manufacturer, as the bearing is placed on the shaft under heavy pressure. The stock number of this shaft is 312P and of the ball bearing 320P. The replacing of this shaft is merely a reversal of the process of its removal but in replacing the steel ring (stock number 319P) be sure the ball bearing is properly centered before tightening down the three holding screws, else there may be vibration. The



The Baird Motion Picture Machine.
View of operating side, closed.
Note- Machine will tilt 17° Between this and 25°, the front legs must be sawed.

Figure 285.

best way to accomplish the centering is to put in the three holding screws, tighten them up and then back them off about one full turn. Now start the motor, and while the projector is running, grasp the steel holding ring between your thumb and finger, and you can tell by the sense of touch when it is properly centered; whereupon tighten up the three holding screws **tight.**

INSTRUCTION NO. 6.—The governor, the weight and parts of which are shown at 145P, P. 2, is held by two ball bearings clamped in the holding casting by screws 853P, P. 2.

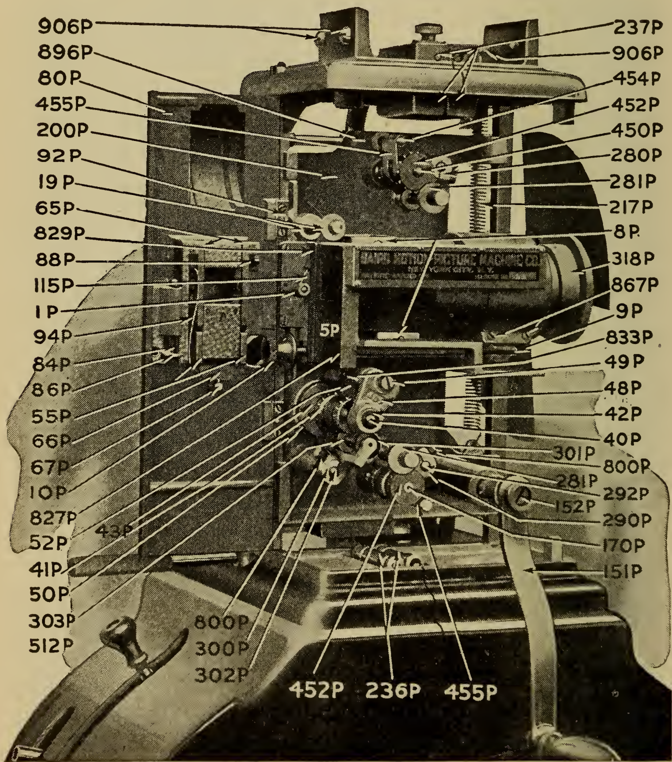


Plate 1, Figure 286.

The entire governor, including the ball bearings, may be removed as a unit by following Instructions Nos. 1 and 2. Then remove taper pin 70P, P. 2, and pull off arm 117P, P. 2. Next remove screw 141P, P. 2, and a similar screw immediately under the arrow head of 853P, P. 2; this releases bar 140P, P. 2. Next loosen screws 853P, P. 2, whereupon the entire governor including the ball races and beveled gear may be pulled out toward the front.

INSTRUCTION NO. 7.—To remove ball bearing 138P, P. 3, and spring 134P, P. 2, follow Instructions Nos· 1, 2 and 6, which release the governor as a unit. Now remove screw 822P, P. 2, and its mate on the opposite side and tap lightly on the end of shaft 130P, P. 3. The ball bearing is just a tight fit, and by tapping lightly on the end of the shaft with a copper or brass punch it will slip off the shaft, and thus releases the governor, weight, spring and sleeve.

INSTRUCTION NO. 8.—To remove spring 134P, P. 2, follow Instruction No. 7.

INSTRUCTION NO. 9.—To remove weight 145 P, P. 2, follow Instruction No.7, and then drive out the pins holding the governon-carrying arms. These pins are not tapered and may be driven either way.

INSTRUCTION NO. 10.—To remove ball race on inner end of governor shaft, follow Instruction No. 7, and then drive out taper pin in hub of gear 136P, P. 2. The large end of each taper pin used in this machine may be recognized by a file mark on the hub behind the head of the pin. Gear and ball race may now be driven off.

INSTRUCTION NO. 11.—To remove flywheel, 26P, P. 2, take out screw in end of shaft and carefully pry off the cap under it, whereupon the wheel may be pulled away. This also releases pinion 27P, P. 2 and 3.

INSTRUCTION NO. 12.—To remove bearing bracket 30P, P. 3, which is also the oil well cover, follow Instruction No. 11. Then pull off pinion 27P, P. 3, remove screws 867P (six of them), P. 2, whereupon the bracket including the cam 34P, P. 2, gear 33P, P. 2, and its shaft 25P, P. 2, can be pulled away as a unit. In removing this bracket pull the parts away carefully, moving them straight outward, then up and to the right, being careful not to strain any part, else you may injure the cam pin or the star or both.

INSTRUCTION NO. 13.—To remove cam 34P, P. 2, follow Instructions No. 11 and 12, and drive out taper pin engaging the hub of what appears to be gear 33P, P. 2, but is in reality the hub of the cam. This will release cam 34P, P. 2, and gear 33P, P. 2. Gear 33P, P. 2, is held to cam 34P, P. 2, by four screws in the back of the cam; by removing these screws the gear is released.

INSTRUCTION NO. 14.—Shaft 25P, P. 2, runs in a bronze bushing pressed into the bracket casting 30P, P. 3. This bushing may be driven out and a new one substituted. The new bushing may be driven in from either direction, but be very careful that you get it started straight, and do not use anything but a hard wood punch to drive it. Proceed carefully and you will have no trouble. The inner end of the bushing should be flush with the casting.

INSTRUCTION NO. 15.—To remove the intermittent unit, which includes shaft 40P, P. 2, star 44P, P. 2, bushing 42P, P. 2, eccentric sleeve 43P, P. 2, collar 45P, P. 2, and intermittent sprocket, 41P, P. 2, proceed as follows: Remove screw 49P, P. 1, and pull off bracket 48P, P. 1. Release screws 833P (two of them), P. 1, and take of intermittent stripper 52P, P. 1. Next remove screw 201P, P. 2. Then raise up on pin 50P, P. 1, which revolves eccentric sleeve 43P, P. 1, and disengages the star from the cam. The intermittent unit may now be removed by grasping the intermittent sprocket and pulling straight out.

INSTRUCTION NO. 16.—To remove intermittent sprocket 41P, P. 2, follow Instruction No. 15 and then drive out the two taper pins in the hub of the sprocket. See recommendation in Instruction No. 57.

INSTRUCTION NO. 17.—To remove both bushings 42P, P. 2, follow Instruction No. 15, drive out taper in the hub of star 44P, P. 2. Intermittent shaft may then be removed from sleeve 43P, P. 2. There are two bushings in this sleeve, and to remove them drive either one clear in against the other bushing and drive the old bushings right on through. In putting in new bushings use nothing but a hardwood punch and be sure to get them started straight. Drive the bushings in at either end of the sleeve until they are flush with the face of the sleeve. See recommendation in Instruction No. 57.

INSTRUCTION NO. 18.—The inner end of shaft 25P, P. 2. is carried by a small bronze bushing. To remove this bushing and to replace proceed as follows: First follow Instruction mittent mechanism. The hole which holds the bushing carrying the end of shaft 25P, P. 2, extends clear through to the other side, its open end being plugged up with a loosely fitting iron plug. Stick a steel nail or any slim punch through the bushing and drive this plug out. Then the bushing may be driven out from either end and the new one driven in. In driving in the new bushing use nothing but a hardwood punch, and be sure to get it started straight. The new bushing may be driven in from either end and its face must be flush with the casting on the inside end.

INSTRUCTION NO. 19.—Gear 176P, P. 2, and its shaft, gear 163P, P. 2; belt wheel 161P, P. 2; gear 158P, P. 2, and the shaft carrying them may be removed as a unit by first disconnecting the motor and the take up belts 659P and 334P, P. 4, and pulling out the hinge pins 338P and 660P, P. 4, then removing screws 872P, P. 2, and two others in the opposite end of Plate 181P. Next remove screw 152P, P. 1, and crank 151P, P. 1, and the taper pin in the shaft behind the hub of the crank. Next loosen screw on the inner end of shaft 455P, P. 1. This screw is on the gate side just between sprocket 452P, P. 1, and the casting. Having released the screws, turn down the stripper plate which comes up between the flanges of the sprocket, and then remove sprocket 452P, P. 1, by loosening the screw in the center of its hub and pulling the sprocket off its shaft; also pull off collar which is on the shaft behind sprocket, after loosening two set screws in its hub. This releases the parts. After having raised the framing carriage as far as it will go, grasp plate 181P, P. 2, and pull the whole thing straight out and away.

CAUTION.—In replacing this part be careful when you put the lower sprocket 452P, P. 1, back on the shaft that it centers properly between the flanges of the idler roller 281P, P. 1 (see Instruction No. 55), and that the stripper plate is raised up into position between the flanges of the sprocket, and its holding set screw well tightened.

INSTRUCTION NO. 20.—The method of driving the machine is as follows: When crank driven, gear 158P, P. 2, which is attached to take up belt pulley and to the crank shaft, drives pinion (stock No. 174) which is secured to the lower sprocket shaft 170P, P. 1. This pinion is just inside the plate 181P, P. 2, and does not show. It drives the lower sprocket shaft and gear 176P, P. 2 and 3 which in turn drives the cam shaft pinion 27P, P. 2 and 3.

When the projector is motor driven, motor pulley 625P,

P. 4, drives friction disc 622P, P. 4, which in turn drives belt 659P, P. 4. Belt 659P. P. 4, drives pinion 163P, P. 2, being attached to pulley 161P, P. 2. Pinion 163P, P. 2, drives lower sprocket shaft gear 176P, P. 2 and 3. Gear 176P, P 2 and 3, then drives the intermittent movement through pinion 27P, P. 2 and 3.

INSTRUCTION NO. 21.—To remove gear 176P, P. 2 and 3, drive out taper pin in its hub, remembering that the file mark

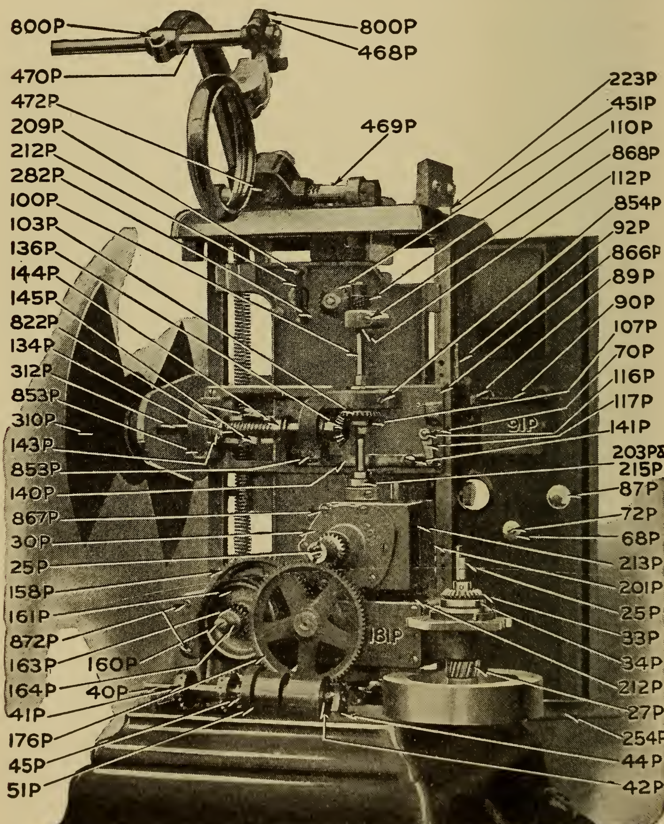


Plate 2, Figure 287.

on the hub is at the large end of the pin. Gear can then be pulled off the shaft.

INSTRUCTION NO. 22.—To remove lower sprocket shaft 170P, P. 3, and the inner pinion thereon, follow Instruction No. 19 and then drive out taper pin in hub of gear 176P, P. 2 and 3, whereupon the shaft can be pulled out on the operating side of the projector.

INSTRUCTION NO. 23.—To remove bronze bushing carrying lower sprocket shaft 170P, P. 1, follow Instruction Nos. 19 and 21, whereupon the bushing may be driven out from either direction, using a hard wood block and hammer for the purpose. In replacing this bushing take note that the bushing is longer than the bearing, and be careful that it projects or extends the same distance as the old one.

INSTRUCTION NO. 24.—To remove belt pulley 161P, P. 2 and gear 163P, P. 2, follow Instruction No. 21 and then loosen set screws (two of them), in collar 162P, P. 3, after which the pulley and gear can be removed.

INSTRUCTION NO. 25.—To remove gear 158P, P. 2, and the belt pulley attached thereto, follow Instruction No. 19 and remove collar 163P, P. 3, whereupon the shaft and gears can be pulled out. Gear 158P, P. 2 and 3, is attached to the crankshaft by means of a taper pin in its hub, and the belt pulley next it is also attached in the same manner.

INSTRUCTION NO. 26.—The crank end of the crankshaft is supported by a bronze bushing. To remove this bushing and replace it with a new one follow Instruction No. 19 whereupon the bushing may be driven out from either direction and the new one driven in, using only a hard wood block for the purpose.

INSTRUCTION NO. 27.—Just below the intermittent oil well in the main frame casting is one of the bushings supporting lower sprocket shaft 170P, P. 1. To remove this bushing and replace it with a new one follow instruction No. 19, whereupon the bushing may be driven out from either direction and the new one driven in, using a hardwood block for driving.

INSTRUCTION NO. 28.—The springs which hold the idler roller bracket to the sprocket are removed or attached merely by slipping them off the studs.

INSTRUCTION NO. 29.—To remove governor bracket 137P, P. 2 and 3, carrying governor and the center ball race of shaft 100P, P. 2 and 3, follow Instructions Nos. 1 and 2, then remove taper pin 70P, P. 2, and arm 117P, P. 2, and pull out shaft 116P, P. 2. Next remove screw 854P, P. 2, and shove upward on gear 103P, P. 2, thus raising both the gear and ball bearing above its supporting casting. Now remove screws 866P, P. 2 (four of them), whereupon part 137P, P. 2 and 3, can be pulled away, carrying with it the governor, gear 136P, P. 2, and link 140P, P. 2.

INSTRUCTION NO. 30.—To remove castings 1P, P. 1, and 2P, P. 3, which support the lens, follow Instruction No. 1, then take out taper pin 70P, P. 2, pull out shaft 116P, P. 2, and remove four screws, one at each corner of the casting, first pulling part 2P, P. 3, in by means of knob 10P, P. 1, far enough to expose the two screws in lens end of casting.

INSTRUCTION NO. 31.—To remove knob 10P, P. 1, and rod 9P, P. 1, look on the under side of casting immediately below rod 9P, P. 1, at the end next knob 10P, P. 1, and you will find a small screw. This screw engages a groove in shaft 9P, P. 1, and after it has been removed, rod 9P and knob 10P may be removed by screwing it out of the arm of part 2P, P. 3. In replacing this part do not forget to tighten up this retaining screw so that it engages with the groove in the shaft, or else the rod will not operate part 2P, P. 3.

INSTRUCTION NO. 32.—Part 2P, P. 3, is the casting which engages or grasps tube 318P, P. 3, which holds the lens. The lens tube itself rests inside part 318P, P. 3, so that when the parts are assembled and the lens is in place, part 318P, P. 3, and the lens tube are tightly clamped together by screw 867P, P. 1 and 3; and since part 318P, P. 3, carries with it shutter blade 310P, P. 2, and shutter shaft 312P, P. 2 and 3, it follows that by adjusting knob 10P, P. 1, the lens and the shutter blade are both moved inward and outward when the lens is focused, and thus the shutter is maintained at all times at a fixed distance from the lens.

INSTRUCTION NO. 33.—Top guide roller 19P, P. 1, is composed of inner flange 18P, P. 3, outer flange 20P, P. 3, and spreading rollers 19P, P. 1, these being held together by spindle 14P, P. 3, and spring 16P, P. 3. This part may be disassembled by removing set screws in the supporting casting just back of arrow head 18P, P. 3. The tension of spring 16P, P. 3, may be varied at will by loosening the holding set screw just back of arrow head 18P, P. 3, and moving shaft 14P, P. 3, slightly in or out.

INSTRUCTION NO. 34.—Aperture plate 5P, P. 1, is held in position by four screws. This plate is made of carbon steel as hard as glass. It may be removed for renewal by taking out four screws, one in each corner.

INSTRUCTION NO. 35.—To remove gate 80P, P. 1, take out the four screws holding the main casting to the posts and then pull the gate away. The hinges are held by dowel pins in addition to the screw.

INSTRUCTION NO. 36.—Automatic fire shutter flap 91P, P. 2, is attached to its shaft merely by being bent around it. Its position on the shaft may be adjusted by holding horizontal rack 88P, P. 1, stationary and lifting or lowering, as

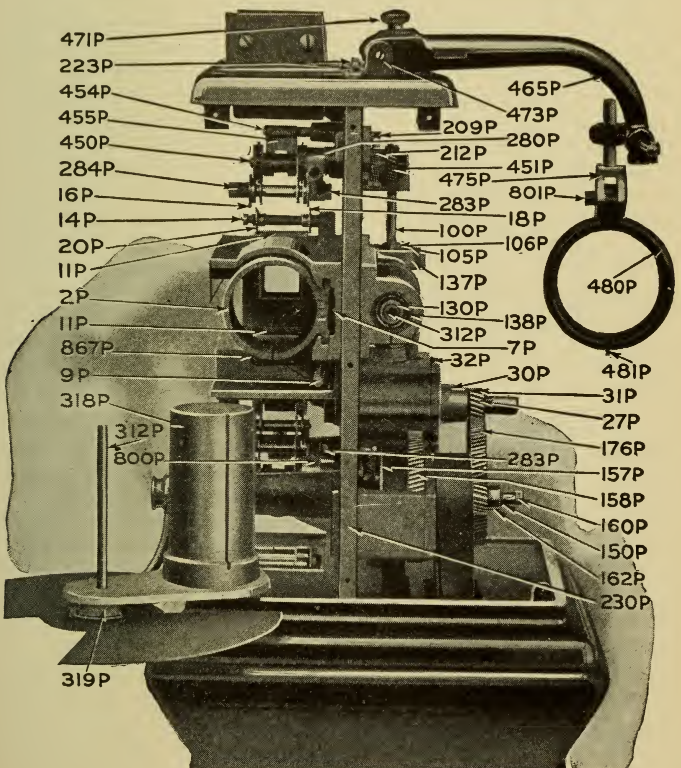


Plate 3, Figure 288.

the case may be, fire flap 91P, P. 2. Fire flap 91P, P. 2, may be removed by driving out the spindle from the pinion end. In replacing hold the corner of a hardwood block against the pinion and drive the shaft into the pinion, after having shoved the shaft through the fire flap. The rack engaging this pinion may be removed by driving it through the gate away from the pinion; use only a hardwood punch for this purpose, the door of course being open or off the projector. This rack should be kept clean and perfectly free at all times, since the shutter drops by gravity alone.

INSTRUCTION NO. 37.—Each of tension shoes 65P, P. 1, is pivoted to a plunger which passes through the gate casting, the shoes being held up against the film by a flat spring, the lower end of which is seen at 66P, P. 1. The tension on this spring is regulated by nut 68P, P. 2, which is attached to a steel screw 67P, P. 1. Thus the projectionist at all times is able to give his tension the finest possible adjustment. Spring 66P, P. 1, is so pivoted that it automatically equalizes the tension between the two shoes.

Lower tension shoes 55P, P. 1, are attached to plate 58P, P. 1, and are held up by a small flat yoke spring at its rear. Plate 58P, P. 1, and lower tension shoes 55P, P. 1, may be removed by taking out screw 878P, P. 1, on the upper end of the plate. Upper tension shoes 65P, P. 1, may be removed by pressing in on the lower end of the shoe until the upper end comes out of its engaging slot; turn upper end toward center of the gate. It will then be released from its pivot pin.

INSTRUCTION NO. 38.—Spring 94P, P. 1, is held by two screws at its lower end, and serves to hold the film over against the steel track at the left of the aperture. It also prevents side motion. The main tension spring supplies tension to the upper shoes. To remove this spring, remove screw 72P, P. 2, in the center of nut 68P, P. 2, taking off nut 68P, P. 2, and pulling out pin 67P, P. 1. In replacing the spring be sure that the depression in its face rests on the fulcrum properly and that its upper ends engage with the plungers of the tension shoes.

INSTRUCTION NO. 39.—Upper sprocket 452, P. 1, may be removed by loosening the screw holding stripper spindle 454P, P. 1 and 3. Swing the stripper up out of the way, loosen the set screw in the hub of the sprocket, and pull sprocket off. In replacing sprocket be careful to get it properly centered between the flanges of its idler rollers.

INSTRUCTION NO. 40.—Upper sprocket shaft 450P, P. 1 and 3, and gear 451P, P. 2 and 3, may be removed by following Instruction No. 39 and then removing collar 453, P. 1, by loosening set screws (two of them) in its hub, afterward pulling shaft and gear out.

INSTRUCTION NO. 41.—To remove gear 110P, P. 2, drive out the taper pin in its hub and raise the gear off by revolving it until it disengages from the teeth of 451P, P. 2 and 3.

INSTRUCTION NO. 42.—To remove shaft 100P, P. 2 and 3, remove screw in top of mechanism which engages main supporting spring 217P, P. 1, then remove nuts 223P, P. 3, and take out the two top screws holding mechanism case to the top of mechanism, which will allow the whole top of the mechanism to be taken off. Next release screw 854P, P. 2, and upper and lower screws 868P, P. 2. Now follow Instruction No. 12, look into the oil well and see the bevel gear on lower end of shaft, attached thereto by a taper pin, remembering that the file mark is at the large end of the pin. Drive this pin out. Next loosen two set screws in collar resting on part 203P, P. 2, and 215P, P. 2, whereupon shaft 100P, P. 2, may be lifted out upward.

INSTRUCTION NO. 43.—The mechanism is held to the lower magazine by four screws, the heads of which are seen by looking underneath the edge of the casting in the top of the lower magazine. Remove these four screws and you may lift the whole mechanism away.

INSTRUCTION NO. 44.—The framing of the carriage is accomplished by means of a segment of a gear and pinion attached to the side of the base of the mechanism. Should anything at any time go wrong with this mechanism you can get at it by removing the machine from the base, whereupon its method of disassembling is self-evident. The framing mechanism under the base operates a vertical screw 247P, P. 4, which engages with a phosphor bronze nut attached to the center of the framing carriage.

INSTRUCTION NO. 45.—The weight of the framing carriage is carried by a vertical spring 217P, P. 1, and if there is a tendency for the carriage to work down proceed as follows: Open the motor compartment door, and looking up at the bottom of the mechanism you will see a half round arrangement with a cap and three screws; this is open at one side. Looking in you will see a small nut which has a right-hand thread. By tightening this nut slightly the tension on the framing handle is increased. Later design has a plate supported by two lugs in place of the half round support, the adjustment being the same.

INSTRUCTION NO. 46.—Where it is desirable to use half-size lens the company furnishes a special mount with a revolving shutter. The half-size lens cannot be used with the regular mount as shown at 318P, P. 1 and 3.

INSTRUCTION NO. 47.—To remove motor drive unit disconnect wires leading to switch and remove belt 659P, P. 4, by taking out pin 669P, P. 4. Looking under casting 621P, P. 4, you will see a horizontal link connected to a vertical lever by a screw. Remove this screw. Next take off nut securing upper end of toggle link to casting 621P, P. 4. Remove screw 658P, P. 4. Motor unit may now be taken out as a whole. Motor may be removed from casting 621P, P. 4, by removing screws in bottom of casting 621P., P. 4, and screws in coupling 650P, P. 4.

INSTRUCTION NO. 48.—In order to remove driving friction wheel which bears on friction disc 622P, P. 4, first follow Instruction No. 47, then remove 638P, P. 4, from shaft 635P, P. 4. This key is held in position by a screw in its face. Next remove three screws in the face of the leather washer 633P, P. 4, which will release disc wheel.

INSTRUCTION NO. 49.—To remove the friction material on face 625P, P. 4, follow Instructions Nos. 47 and 48 and then remove screws in the outer end (you cannot see them in the cut) of the friction wheel. This releases the friction material, which may be removed and new material be secured from the manufacturer and put in its place. The friction material will need no turning or trueing up after being put in.

INSTRUCTION NO. 50.—To remove disc wheel 622P, P. 4, release the set screw in the belt pulley on the shaft of the disc, after first having released the screw in the rim of knurled adjusting nut on the rear end of the shaft. Back this nut off, whereupon you may pull the friction disc and shaft away.

INSTRUCTION NO. 51.—To adjust the intermittent sprocket and cam in order to eliminate lost motion in the intermittent, first loosen screw 201P, P. 2, and screw 49P, P. 1, after which slightly turn eccentric sleeve 43P, P. 1, by pressing down on projecting pin 50P, P. 1, at the same time revolving the flywheel by hand. When you think you have it just about right tighten up screw 201P, P. 2, and try the intermittent sprocket with your fingers. See General Instruction No. 5. When you have the adjustment made to your satisfaction tighten up screw 49P, P. 1, and the adjustment is completed.

CAUTION.—Should you, for any reason, remove bracket 48P, P. 1, be very sure that its face and the face it fits on are perfectly clean when you put them back, because dirt might and probably would throw the part out of line and cause shaft 40P, P. 1, to bind in bushing 42P, P. 1. Also be very sure that screw 201P, P. 2, is set up tight. If it is not it will cause trouble.

INSTRUCTION NO. 52.—End motion in the intermittent sprocket (see General Instruction No. 6) may be removed by loosening the screw in the steel collar between intermittent sprocket 41P, P. 1, and eccentric sleeve 43P, P. 1, and prying lightly against the rim of the sprocket with a screwdriver, letting the point of the screwdriver rest on the collar, which will have the effect of forcing the sprocket to the right and the collar to the left. Tighten up the screw in the collar while it is held in this position.

INSTRUCTION NO. 53.—In threading the projector, when you raise the lower sprocket idler do not jerk it up as though you were working with a two-inch bar. Rough handling of this idler may get it out of line with the sprocket, which will cause the losing of the lower loop. (See General Instruction No. 12).

INSTRUCTION NO. 54.—The quantity of oil in oil well 213P, P. 2, should only be sufficient so you can see the oil splash on the oil window when the machine is running. In order to clean out oil well 213P, P. 2, remove the screw immediately below the glass window, which will allow the oil to drain out, you of course providing something for the oil to run into. Replace the screw, flood the well with kerosene and give the machine a few turns, after which remove the screw, drain out the kerosene and put in fresh oil. (See General Instruction No. 1).

INSTRUCTION NO. 55.—With regard to the idler rollers (see General Instruction No. 12), in order to change the distance of idler rollers from the sprocket, loosen the clamping screw in the hub of bracket, one of which is shown at 800P, P. 1, which will allow of moving the bracket on its shaft. In making this adjustment be very careful not to move the hub of bracket away from the main casting, which would cause the idler to be out of line with the intermittent sprocket.

INSTRUCTION NO. 56.—Upper and lower sprockets may be turned end for end on their shafts in order to present a

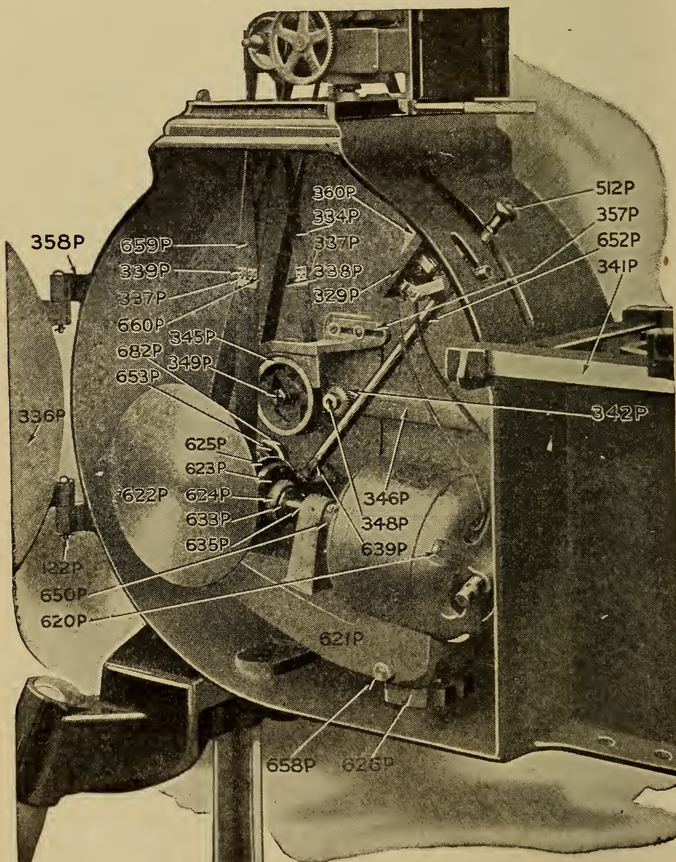


Plate 4, Figure 289.

new tooth surface to the film, if the teeth are worn on one side.

INSTRUCTION NO. 57.—We would by all means advise all purchasers of the Baird projector either at the time of purchase or later on to secure a complete part comprised of 40P, 41P, 51P, 42P and 44P, P. 2. Then when your intermittent sprocket, shaft, bushing or star is worn, all you have to do is to remove the complete part, substitute the new one and send the old one to the factory for inspection and repairs. This is in every way much better than to attempt to put on a new intermittent sprocket. The intermittent sprocket is the heart of a moving picture projector, and it must not only be true down to as little as one-tenthousandth of an inch, but it must be mounted absolutely true also, and the projectionist is seldom in a position to do a delicate job of this kind properly.

INSTRUCTION NO. 58.—The wear of the bushing carrying shaft 170P, P. 1, supporting lower sprocket 452P, P. 1, will have the effect of increasing the distance between the sprocket and its idler. Should you begin to have trouble with losing the lower loop, first see if you can move the outer end of the lower sprocket up and down perceptibly. If you can, the bushing is probably somewhat worn and the distance between sprocket and idler has increased. The remedy is to loosen the idler. (See Instruction No. 55.) When you are making this adjustment hold down on the sprocket; then adjust idler roller to suit this condition.

INSTRUCTION NO. 59.—There should be just sufficient pressure between friction disc wheel 622P, P. 4, and driving friction wheel to cause disc wheel 622P, P. 4, to continue to revolve when belt 659P, P. 4, is slipping on pulley. This pressure is regulated by a knurled nut at the rear end of the shaft, carrying disc-wheel 622P, P. 4. To test the drive, start the motor and grasp the flywheel firmly, causing the belt to slip on the pulley. Any unnecessary pressure between friction disc-wheel 622P, P. 4, and the driving friction wheel will cause excessive wear and loss of power and probably heating of the motor.

INSTRUCTION NO. 60.—At the lower end of rod 639P, P. 4, is a casting supported by a stud attached to the rear wall of the compartment. This casting is supported on the stud by a clamp lined with fibre. Should at any time the knob 512P, P. 4, develop a tendency to work up or down while the motor is running, tighten the screw in this clamp bushing sufficiently to hold the rod in place and prevent the knob from moving through vibration of parts.

INSTRUCTION NO. 61.—On the operating side of the projector at the bottom of the magazine is a horizontal lever, the purpose of which is to raise the discwheel end of part 621P, P. 4, thus releasing belt 659P, P. 4, which operates as follows: When ready to start the show raise the lever up and start your motor by throwing in the handle of switch 329P, P. 4, next set speed regulating knob 512P, P. 4, in running position, if it is not already there. Now when you are ready to project the picture drop the lever slowly down with one hand and as the fire shutter raises raise the dowser with the other hand.

INSTRUCTION NO. 62.—Belt 334P, P. 4, operates the takeup. The take-up gear 342P, P. 4, is on take-up spindle, 348P, P. 4, which carries the lower reed. This spindle is supported by bar 346P, P. 4, which is hinged to the machine casting on the opposite side, just back of the figures 342P, P. 4. The front end of this lever, including the take-up spindle, rests in and is supported by belt 334P, P. 4. The result is that when the reel in the take-up magazine is empty there is very little friction on this belt, but as the film is wound on the reel the weight increases, and thus an automatically regular takeup tension is supplied in excellent form.

INSTRUCTION NO. 63.—Any angle may be given the projector as a whole by loosening the clamps which secure the legs and raising or lowering the projector to secure the desired setting.

INSTRUCTION NO. 64.—The condenser is supported in a metal casing which forms a heat reservoir and will go far toward reducing lens breakage. The casing is so designed that it may be adjusted to suit various conditions. It is advisable that the lens be kept about one-sixteenth of an inch apart.

INSTRUCTION NO. 65.—On the top of the carbon clamp of your lamp, under the clamping screw, is a hole which should be kept filled with powdered graphite at all times. Do this and you will have no trouble with your carbon clamp screws working hard.

INSTRUCTION NO. 66.—The cups on the motor should be kept filled with a good grade of medium oil.

NAMES AND NUMBERS OF PARTS FOR BAIRD PROJECTOR.

Order parts by number only. These numbers are the manufacturers' regular stock numbers. The first column indicates the number of the plate or plates upon which the part appears.

Plate.	No.	Description.
1	— 1P	Bracket for lens and aperture plate.
3	— 2P	Slide for ¼ size lens and shutter guard.
1	— 5P	Aperture plate.
3	— 7P	Spring between lens bracket and slide.
1	— 8P	Frame to hold glass on lens bracket.
3 & 1	— 9P	Screw to adjust lens.
1	— 10P	Knob of lens adjusting screw.
3	— 11P	Glass for lens bracket.
3	— 14P	Pin for film guiding roller.
3	— 16P	Spring for film guiding roller.
3	— 18P	Roller for back edge of film.
1	— 19P	Spreader roller for guiding film.
3	— 20P	Roller for front edge of film.
2	— 25P	Cam shaft.
	— 26P	Fly wheel.
3 & 2	— 27P	Pinion for cam shaft.
	— 28P	Washer for fly wheel.
	— 29P	Screw to hold fly wheel pinion on cam shaft.
3 & 2	— 30P	Bracket for outside bearing on cam shaft—cover for oil well.
3	— 31P	Bushing for outside bearing on cam shaft.
3	— 32P	Gasket for cam shaft bearing.
2	— 33P	Bevel gear on cam shaft.
2	— 34P	Cam.
1 & 2	— 40P	Intermittent shaft.
1	— 41P	Intermittent sprocket.
2 & 1	— 42P	Bushings for intermittent shaft.
1	— 43P	Eccentric sleeve.
2	— 44P	Star wheel.
2	— 45P	Collar on intermittent shaft.
1	— 48P	Bracket for outside bearing on intermittent shaft.
1	— 49P	Screw for bracket on intermittent shaft.
2	— 50P	Pin to adjust eccentric sleeve.
2	— 51P	Gasket for eccentric sleeve.
1	— 52P	Stripper for intermittent sprocket.
1	— 55P	Lower tension shoe.
	— 59P	Spring for lower tension shoe.
1	— 65P	Upper tension shoe.
1	— 66P	Spring for upper tension shoe.
1	— 67P	Adjusting screw for upper tension shoe.
2	— 68P	Adjusting nut for upper tension shoe.
2	— 72P	Screw stop for adjusting nut for upper tension shoe.
1	— 80P	Gate.
	— 81P	Spring for locking pin on gate door.
1	— 84P	Plunger for locking gate door.
	— 85P	Pin for releasing locking plunger on gate door.
1	— 86P	Foot on gate door plunger.
2	— 87P	Knob for releasing pin on gate.
1	— 88P	Rack for fire shutter.
2	— 89P	Pinion for fire shutter.
2	— 90P	Shaft for fire shutter.
	— 91P	Fire shutter.
1 & 2	— 92P	Hinges.
1	— 94P	Spring for edge of film.
3 & 2	—100P	Vertical shaft.
	—101P	Bevel gear on lower end of vertical shaft.
2	—103P	Bevel gear on center of vertical shaft for D. C. projector.
	—104P	Ball bearing for center bevel gear on vertical shaft.
3	—105P	Bevel gear on center of vertical shaft for A. C. projector.
3	—106P	Nut for center bevel gear on vertical shaft.
2	—107P	Driving collar on vertical shaft.
2	—110P	Gear on top end of vertical shaft.
2	—112P	Bushing for top end of vertical shaft.
1	—115P	Lever engaging fire shutter rack.
2	—116P	Shaft carrying levers operating fire shutter.
2	—117P	Lower lever operating fire shutter.
3	—130P	Governor shaft.
	—131P	Pins for governor balls.
	—132P	Pins for collars on governor shaft.
2	—134P	Spring for governor for D. C. projector.
	—135P	Bevel gear on governor shaft for A. C. projector.
2	—136P	Bevel gear on governor shift for D. C. projector.
3	—137P	Bracket carrying governor shaft.
3	—138P	Ball bearings on governor shaft.

Plate.	No.	Description.
	—139P	Spring for governor for A. C. projector.
2	—140P	Link connecting governor and fire shutter.
2	—141P	Screws to guide governor connecting link.
	—142P	Sleeve on governor shaft.
2	—143P	Fixed collar on governor shaft.
2	—144P	Sliding collar on governor shaft.
2	—145P	Balls for governor.
	—146P	Arm for governor.
3	—150P	Crank handle shaft.
1	—151P	Crank arm.
1	—152P	Screw to hold crank arm.
	—155P	Driving pin in crank handle shaft.
3	—157P	Pulley on crank handle shaft.
3 & 2	—158P	Helical gear on crank handle shaft.
3 & 2	—160P	Oil cup on end of crank handle shaft.
2	—161P	Pulley for motor belt on crank handle shaft.
3	—162P	Collar on crank randle shaft.
2	—163P	Pinion on crank shaft for motor drive.
2	—164P	Bushings for pinions on crank handle shaft.
1	—170P	Lower sprocket shaft.
	—174P	Pinion on lower sprocket shaft.
3 & 2	—176P	Helical gear on lower sprocket shaft.
	—181P	Bracket for carrying lower driving gears.
	—185P	Bushing for gear end of crank handle shaft.
	—186P	Bushing for gear end of lower sprocket shaft.
1	—200P	Sliding main frame.
2	—201P	Screw to lock eccentric sleeve.
	—202P	Bushing for inside bearing on cam shaft.
2	—203P	Bushing for lower end of vertical shaft.
	—205P	Bushing for upper sprocket shaft.
	—206P	Bushing for crank end of crank handle shaft.
	—207P	Bushing for sprocket end of lower sprocket shaft.
2 & 3	—209P	Hook pins for bracket springs.
	—210P	Nut for framing.
	—211P	Plug for cam shaft bearing hole.
2 & 3	—212P	Spring for sprocket brackets.
2	—213P	Glass in front of oil chamber.
	—214P	Glass in top of oil chamber.
2	—215P	Cup for bushing on lower end of vertical shaft.
1	—217P	Spring to support main frame.
	—220P	Post carrying gate door.
3 & 2	—223P	Nuts for top of posts.
	—224P	Nut for bottom of posts.

Plate.	No.	Description.
3	—230P	Post for front end.
1	—236P	Rollers for upper and lower fire valves.
1	—237P	Pins for upper fire valve rollers.
	—249P	Pinion on framing screw.
	—251P	Spring on framing screw.
	—253P	Gear for framing.
2	—254P	Handle for framing.
	—256P	Bracket for fire rollers, front.
	—257P	Pins for lower fire valve.
	—258P	Bracket for fire rollers. rear.
	—259P	Fibre washer for framing screw.
3 & 1	—280P	Bracket carrying roller for upper sprocket.
1	—281P	Rollers for upper and lower sprockets.
2	—282P	Arm for spring on roller bracket shaft.
3	—283P	Nut for sprocket roller shaft.
3	—284P	Sraft for upper and lower sprocket rollers.
	—290P	Bracket carrying rollers for lower sprocket.
1	—292P	Shaft for bracket for lower sprocket.
1	—300P	Bracket carrying rollers for intermittent sprocket.
1	—301P	Shaft for roller for intermittent sprocket.
1	—302P	Shaft for bracket for intermittent sprocket.
1	—303P	Roller for intermittent sprocket.
2	—310P	Shutter for D. C. projector.
	—311P	Hub for shutter.
2 & 3	—312P	Shaft for shutter.
	—313P	Washer clamp for shutter.
1 & 3	—318P	Tube carrying lens.
3	—319P	Casing for ball bearing.
	—320P	Ball bearing.
	—321P	Shutter for A. C. Projector.
4	—329P	Switch for motor.
4	—334P	Belt to drive lower reel.
3	—336P	Door for motor compartment.
4	—337P	Fastener for belt.
4	—338P	Rawhide pin for belt fastener.
4	—339P	Rivet for driving belt.
	—340P	Stationary bracket carrying lamphouse.
4	—341P	Track bars for stationary bracket.
4	—342P	Gear on lower reel shaft for small reel 1¾ core.
4	—345P	Gear and pulley for driving lower reel.
	—346P	Arm carrying lower reel.
4	—348P	Shaft for lower reel.
4	—349P	Pin carrying pulley on lower reel arm.
	—350P	Collar on lower reel shaft.
	—351P	Latch for lower reel shaft.
	—352P	Plunger in lower reel shaft.
	—353P	Spring in lower reel shaft.
	—354P	Pin for latch in lower reel shaft.

Plate.	No.	Description.
4	—357P	Guard for belt on arm carrying lower reel.
3	—358P	Lug for hinge on stand.
4	—360P	Bracket for motor switch.
1 & 3	—450P	Shaft for upper sprocket.
3 & 2	—451P	Gear on upper sprocket shaft.
1	—452P	Upper sprocket and lower.
	—453P	Collar on upper sprocket shaft.
3 & 1	—454P	Shaft for upper sprocket stripper.
3 & 1	—455P	Stripper for upper sprocket and lower.
3	—465P	Main arm carrying stereopticon.
2	—468P	Coupling between stereopticon arm and lens.
2	—469P	Rack for stereopticon arm.
2	—470P	Rod for stereopticon arm.
2 &3	—471P	Knob for adjusting stereopticon.
2	—472P	Pinion for stereopticon.
3	—473P	Pivot pins for stereopticon rack.
3	—475P	Yoke end for stereopticon.
	—476P	Collar on stereopticon rack.
3	—480P	Housing for stereopticon lens.
3	—481P	Retaining ring for 2⅞" stereopticon lens.
	—482P	Stereopticon lens 2⅞".
4	—621P	Frame for friction drive.
4	—622P	Friction driven disc.
4	—623P	Hub for driving friction wheel.
4	—624P	Arm for moving driving friction wheel.
4	—625P	Face for driving friction wheel.
4	—626P	Pivot base for motor frame.
	—627P	Clamp washer for face of driving friction wheel.

Plate.	No.	Description.
	—628P	Pulley on shaft of driven friction disc.
	—629P	Bushing for driven friction disc shaft.
	—630P	Bushing for ball bearing end of driven friction disc.
	—631P	Bushing for driving shaft on motor drive.
	—632P	Adjusting nut for driven friction disc.
4	—633P	Retaining washer on hub of driving friction wheel.
4	—635P	Shaft for driving friction wheel.
4	—639P	Friction lever for moving friction wheel.
4	—650P	Leather band for flexible coupling.
4	—652P	Rod for speed control.
4	—653P	Ball bearings for friction drive.
4	—659P	Belt for motor drive.
4	—660P	Rawhide pin for driving belt fastener.
2-1-3	—800P	Clamp screws.
2	—822P	Stock screw.
1	—827P	Stock screw.
1	—829P	Stock screw.
	—801P	Clamping screw.
1	—833P	Machine screw, stock.
2	—853P	Stock machine screw.
2	—854P	Stock machine screw.
3 & 2	—867P	Stock machine screw.
2	—868P	Stock machine screw.
2	—872P	Stock machine screw
1	—896P	Sstock machine screws.
1	—906P	Stock machine screw.
2	—866	Stock machine screw
2	— 70	Pin.
3	—801	Nut holding housing 480 tc yoke 475.
4	—122	Pin for hinge of door 336.

KNOWLEDGE IS POWER

Various Types of Light Source

THERE are now in use (1927) four available light sources for motion picture projection. Each of these sources differs widely from the other in the matter of efficiency of results obtained per watt of electric energy expended, each producing a distinctly different result in the items of screen illumination and light tone, and each demanding expert adjustment and handling in order to produce maximum results—especially maximum results at a minimum consumption of electric power and expense for replacement of apparatus, or parts thereof.

These various light sources are (a) the ordinary electric arc (b) the high intensity arc, (c) the reflector arc lamp and (d) the incandescent, the latter commonly, though erroneously dubbed the "Mazda."

Each of these light sources, except perhaps the first named, which is the oldest of them all, has an appropriate place in theatrical motion picture projection, the particular one best suited for use in any particular installation being entirely dependent upon (a) local conditions and (b) the individual ideas of the management as to what combination of screen brilliancy and light tone is most pleasing and satisfactory.

Broadly, the high intensity produces a very bright screen and a harsh light tone. It consumes a maximum amount of electric power and carbons. It is a very hot light source, hence is very hard on collector condenser lenses, and on certain of its own parts. Put in another way, it is expensive in operation, but gives a maximum screen illumination—the brightest that can be had with any present known light source.

The ordinary arc is relatively expensive in operation. It consumes much carbon and electric power for the intensity of screen illumination produced; also, unless very expertly handled, there is a possible and probable heavy loss of light. On the whole the ordinary arc is highly inefficient. It should be entirely superceded by the other light sources herein described.

The incandescent lamp, provided it be well handled, not only produces excellent results, but also produces them with a high degree of efficiency. The screen illumination, while not what could be termed brilliant, is most soft and pleasing in tone. The lamp radiates comparatively very little heat, hence is comfortable to handle in summer, or in hot climates; also it neither breaks nor in any way injures the collector lens.

Until recently this light source was hampered by being compelled to work with a condenser not at all suited to its needs. That difficulty has, however, been overcome. Thanks to the Bausch and Lomb Optical Company and its efficient engineers, a condenser suited to the needs of the incandescent is now available. Its advent has enormously increased the efficiency of results, and has largely added to the range of operating conditions the incandescent can cover with satisfaction to all concerned.

The Reflector Type Arc lamp is the newest arrival in the projection light source field. It is not too much to say that the results obtained with it were little less than astounding to old timers in projection when they first were viewed. When the author of this book first witnessed a demonstration in which a twenty ampere reflector type arc fully equalled the best performance of a 75-ampere ordinary arc he could scarcely believe the evidence of his eyes. It was all quite correct, however, and the reflector arc lamp has leaped into favor because of its enormous efficiency in the production of pure white screen illumination, at a minimum expenditure of electric energy, carbon and replacements.

Today some of our best Broadway theatres—high-priced houses—are getting highly satisfactory results with reflector type lamps using twenty to twenty-five amperes. These theatres formerly used the ordinary arc, and as high as 120 amper with very little if any better results.

We therefore recommend to projectionists and theatre managements that the ordinary arc be discarded in favor of either the high intensity arc, the reflector arc lamp or the incandescent—the high intensity only in cases where the maximum possible intensity of screen illumination is demanded.

THE HIGH INTENSITY ARC LAMP.—In the High Intensity lamp the positive carbon rests in a horizontal position, with its center exactly upon the optical axis of the projector optical train. This gives it an enormous advantage as against the ordinary arc, because its crater faces the collector lens squarely, and in exactly the correct position, whereas the crater of the ordinary arc canot possibly be maintained in good form at an angle of less than thirty-five degrees with the face of the collector lens; also it is not perfect as to form, or necessarily central upon the optical axis of the projector optical train.

From this we understand that whereas the high intensity crater directs its strongest light flux straight toward the center of the condenser, the ordinary arc, due to the position of its crater, sends forward its strongest light flux toward the lower half of the condenser and the front, lower end of the lamphouse wall.

Another point in favor of the high intensity is that the brilliancy of the high intensity arc crater per unit area is very much higher than is that of the ordinary arc crater. The brilliancy of the ordinary arc crater when operating with cored carbons is given by Blondel as 132 c. p. per square m. m., but by reason of modern improvement in projection carbons this is claimed to be increased to about 160 c. p.

Engineers claim a brilliancy of 500 c. p. per square m. m. for the high intensity arc. We have not verified this claim, but certainly the high intensity arc crater has a very much higher brilliancy per unit area than has the crater of the ordinary arc. That last statement is not a subject for questioning.

The crater area per ampere is decidedly less than that of the ordinary arc. By this we mean that a 75-ampere high intensity crater, for instance, will have very much less diameter and area than will a 75-ampere ordinary arc crater. Exactly how great an advantage this is we are not prepared to say, but certainly it is an advantage because it seems quite possible to secure all the screen brilliancy any reasonable man could want without encountering the inefficiency under which the ordinary projection arc labors when working at high amperage. See pages 393 to 396.

The point of highest efficiency of the ordinary D C arc is about 60 amperes. We believe there would be no appreciable loss in efficiency with the high intensity arc until the 100 ampere, or possibly 120 ampere, point was passed.

COLOR OF LIGHT.—Screens illuminated by the high intensity arc are very brilliant, but the light tone is not, at this time (1927) as warm in tone as is the light from the ordinary arc. Nothwithstanding this phase of the matter, which may be corrected later, the public seems to like the high intensity screen illumination. We have not heard a single theatre patron criticize it adversely, but have heard many express approval of the brilliancy of the light.

CURRENT STRENGTH.—High intensity carbons are designed to work at a certain definite amperage. See page 400½ If you want the best results do not depart therefrom. If you do depart therefrom and trouble and damage to the apparatus results, do not blame anyone but yourself.

There are those who think that because they can operate an ordinary arc lamp at almost any desired amperage, they can do the same with the high intensity lamp. If you have any such idea you had better revise it, and come to an understanding of the apparatus you are handling. If your lamp is rated at 75 amperes and 60 volts, that amperage and voltage must be maintained for best results, though no serious damage will follow if the amperage does not run above 80 or drop below 70.

In this connection the General Electric Company submits the following information:

"The high intensity arc has been the subject of a vast amount of study and experimentation. One of the latest and most interesting experiments was an exploration of the current-light characteristics. It was particularly desired to find how a 120-ampere electrode operated at say 90 amperes compared with an electrode designed for 90 amperes. Many of the picture houses have supply and converter equipment that is limited in capacity and they are thus not free to operate under the best conditions. It is often the case that 90 or 100 amperes is the limit of current and the lamp in this case is run far below rating.

In making these tests the lamp was equipped with standard condensers and the light was projected as previously described. The 120-ampere electrodes were operated at 120,110,100 and 90 amperes. Taking the light received on the screen at the highest current as 100% the other currents gave 81%, 62% and 41%. We may, therefore, say that when near normal rating the light falls off 2.3 times as fast as the current. Thus, if the current is lowered by 10% the light falls off 23%. If the current is dropped to 90 amperes, a decrease of 25%, the light will decrease 59%. If, on the other hand, an electrode designed for 90 amperes were used, the loss of light would be only 30%. We may make the comparison in another way. A 75-ampere standard carbon at 75 amperes will give as much light on the screen as a 120-ampere carbon at 97 amperes. There are many factors to be considered in an actual installation that have not been mentioned here, but the figures given above show that in choosing the lamp or the current the high intensinty arc must be considered as a new and different light to which the older rules of arc practice do not apply.

In a great number of cases theatre owners and projectionists insist on having 100 ampere high intensity lamps. In these 100-ampere high intensity lamps it is necessary for them to use what are known as 13.6 mm. positive carbons. These carbons work at their highest efficiency only when burned at 120 amperes and if burned below this amperage their efficiency drops off tremendously. It is, therefore, true that where the 120-ampere carbon is burned much below the 120-ampere rated capacity far superior results would be obtained by the use of a 75-ampere carbon known as the 11 mm. carbon burned at a trifle above its maximum carrying capacity, viz. 80 amperes. It is true that if the 75-ampere carbon is burned at 80 amperes the amount of light given off will far exceed the light given off by the 120-ampere carbon when burned at 100 amperes.

One hundred readings in two separate groups of fifty each were taken in order to determine the above fact and the data of this test is as follows: The current and terminal voltages at which the test was made were:

90	amperes,	60	volts	at	lamp	terminals
100	"	63	"	"	"	"
110	"	66	"	"	"	"
120	"	70	"	"	"	"

Taking the output at 120 amperes as 100% the other currents gave percentages as below:

90	amperes	42	per	cent
95	"	51	"	"
100	"	61	"	"
105	"	71	"	"
110	"	80	"	"
115	"	90	"	"
120	"	100	"	"

CARBONS.—Under no conditions attempt to use any other than high intensity carbons. Positive High Intensity carbons rated at 75 to 80 amperes are 11 mm. (approximately 7/16") in diameter by 20″ long, the corresponding negative carbon being ⅜″ in diameter by 9″ long and metal coated. Positive High Intensity carbons rated at 100 to 120 amperes are 13.6 mm. (approximately 9/16″) in diameter by 20″ long with the corresponding negative 7/16″ in diameter by 9″ long, metal coated.

THE GENERAL ELECTRIC LAMP—The General Electric Company and the Nicholas Power Company, working in conjunction, have developed a high intensity lamp, illustrated in Figs. 299 and 300, which same is being put out as special equipment by the Power's Division of the International Projector Corporation. Fig. 299 shows right-hand and Fig. 300, left-hand side of the lamp.

In general the operation of the lamp is as follows: The carbons, both positive and negative, are fed by a small motor located under the base of the lamp. The motor armature and field are connected across the arc, which has the effect of

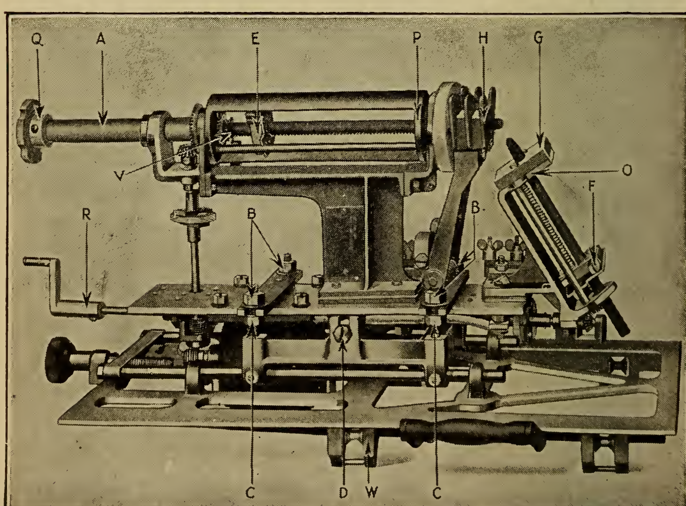


Figure 299

increasing the speed of the motor when the arc length is increased and the arc voltage, therefore, increased; or slowing down the motor when the arc gets shorter. This is precisely the principle upon which some of the oldest and best arc controllers operate and its application to this lamp should maintain the arc automatically with but very little attention. Knob Q and crank R, Fig. 299, are for the purpose of feeding the carbons by hand, when, or if, necessary.

The positive carbon is pushed through an opening in tube A, Fig. 299, and shoved through clamp E and positive contact shoes H, until its tip extends 9/16 of an inch as per Fig. 301.

The carbon is held by clamp E, Figs. 299 and 300, which clamp engages with feed screw M, Fig. 300. Positive carbon clamp E is insulated so that no current can enter the carbon through the clamp. This prevents the carbon heating by having current forced through its entire length, it also prevents positive feed screw M and negative feed screw L, Fig. 300, from carrying current which might cause disastrous arcing between the clamp and feed screw.

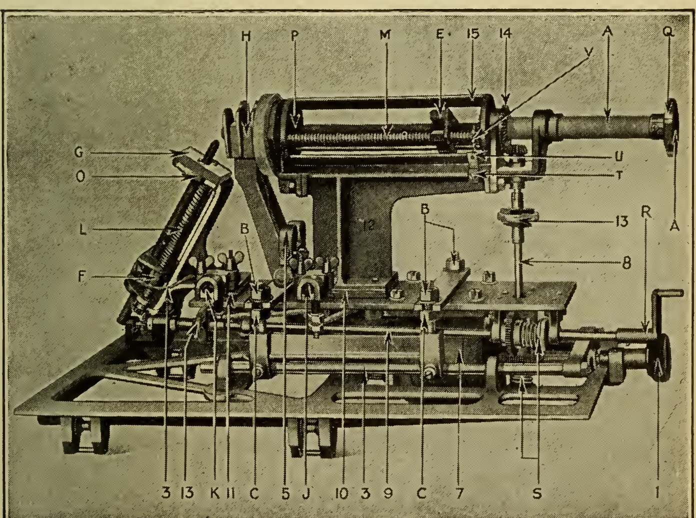


Figure 300.

CURRENT ENTERS THE CARBON.—Current is conducted to the positive carbon through the floating contact shoes, shown at H, Figs. 299 and 300. These contact shoes are held in contact with the carbon by the action of a coil spring and are so arranged that they may make a firm and even contact with the carbon at all times.

The current enters the negative carbon through carbon clamp F, Figs. 299 and 300. Current is supplied to this clamp through flexible wire jumper, shown at 3, Fig. 300. The negative carbon is a metal coated carbon and the current is conducted from the clamp through the full length of the carbon. Both the negative clamp F and the positive carbon clamp H are insulated from the body of the lamp. This is illustrated in Fig. 302, the dotted line representing the path followed by the current through the lamp.

POSITIVE CARBON ROTATED.—From Q to P, Figs. 299 and 300, the parts form one assembly. Looking at Fig. 300, between the arrowheads 14 and 15, you will see directly in front of gear to which arrow 14 is pointing, a casting which forms one end of the support for the positive carbon carriage. The other end of this carriage is supported by a similar casting between arrows H and P, directly behind positive contact shoes H and asbestos baffle plate. This carriage, including part A and Knob Q, is continuously rotated by the motor, carrying with it, of course the positive carbon, as well as feed screw M and clamp E, both of which are mounted on the carriage. The rotation of the positive carbon maintains at all times a perfectly round and symmetrical positive crater.

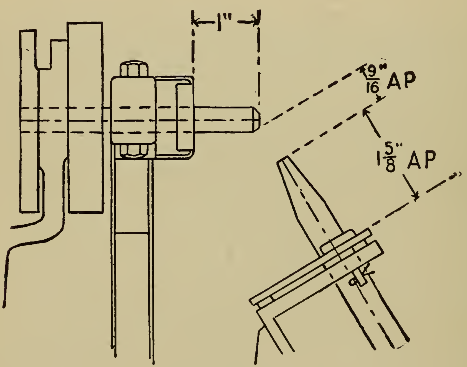


Figure 301.

The positive carbon is not fed continuously, but intermittently. This is accomplished as follows: On the rear end of positive feed screw M, a ratchet wheel is mounted, indicated by V, Fig. 300. On the stationary frame of the lamp, U, Fig. 300, is a spring pawl and every time the positive carbon carriage rotates, this pawl engages the ratchet and pulls it and the positive feed screw around slightly.

Adjustment screw T, Fig. 300, is provided to enable the projectionist to regulate the rate of feed of positive carbon.

SAFETY CLUTCHES.—The motor is directly connected, through gearing, to the feeding mechanism and there is provided, both as a safety device and to enable the projectionist to feed the carbons by hand without disconnecting the motor, a spring pressure friction clutch, which is placed on both the positive and negative feed rods. They are indicated at S, Fig. 300. The gear at the front end of the clutch is not connected to the shaft but rotates loosely thereon. It is held, or gripped, between two collars, one of which, the one between the support bearing and the gear, is attached to the feed shaft and must rotate therewith. The pressure is applied by a coil spring which rests against the collar which rotates loosely with the gear. This pressure can be adjusted by tightening or loosening the hexagon lock nut on which arrowhead S is resting. By examining this construction, you will see that if crank R is turned with sufficient force, the feed rod will be rotated although the gear must remain stationary or may be running with the motor. When crank R is rotated, the friction supplied to the clutch by the coil spring is overcome and the carbons are thus fed by hand, regardless of whether or not the motor is running.

These clutches act as safety devices as follows: If either the positive or negative carbon be burned too short, the positive clamp E will strike the front of the carriage at P, Fig. 300, or negative clamp F will strike the negative head at O, Fig. 299. When this happens the feed screw could feed the clamp and carbon no further and the motor would instantly be stalled with probable serious injury to its armature. In that event, however, the clutches operate and allow the motor to continue running although under heavy load.

HAND FEEDS WORK HARD.—For the reason that in order to operate the hand feeds the clutches must be slipped, these feeds work hard.

NOTE.—The pressure of the springs operating the clutches must be sufficient to enable the motor to drive the feeding mechanism, but not so great that the feeding mechanism will work unnecessarily hard, or that the motor will be stalled if one of the clamps strikes, as before described.

THE NEGATIVE CARBON is fed upward by feed screw L, acting through carbon clamp F. The feeding is not intermittent but continuous. The negative is not rotated. It may be fed by hand by means of crank R, Figs. 299 and 300.

INSTALLATION.—The lamp is installed in the lamphouse by the manufacturer, the lamp and lamphouse not being sold separately for an original installation. It is so adjusted by the manufacturer that the center of the positive carbon is exactly on the optical axis of the lens system. It is, however, possible that the adjustment may be altered in shipment, or it may be that you will have occasion to order a new high intensity lamp to install in place of an old one.

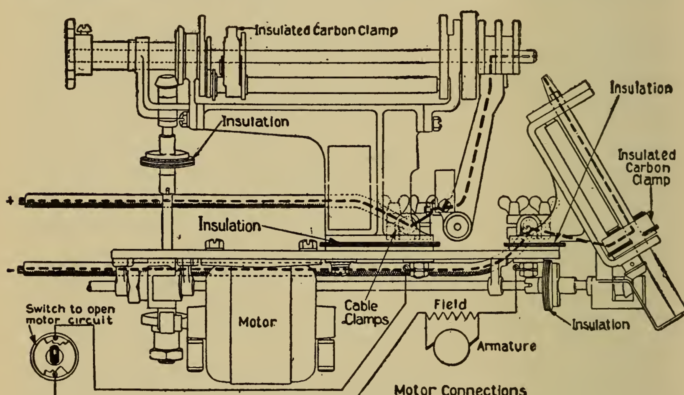


Figure 302.

On receipt of a new high intensity outfit, or when you install a new lamp in the place of an old one, you should set the alignment of the lamp, as follows: Secure a perfectly straight rod of steel or iron having the same diameter as the positive carbon (11 m.m. or about 7/16 of an inch) and long enough to reach from an inch or more back of knob Q to the front of the projection lens tube. Test the rod for straightness by rolling it on a perfectly flat surface. Remove the condenser lenses, open the projector mechanism gate, and take out both combinations of the projection lens, placing the empty lens barrel back in place in the holder. Remove the positive carbon and shove the iron rod through tube A, clamp E, positive contact shoes H and on through the aperture and lens barrel. If the rod is exactly central with the aperture (use an inside calliper for measuring) and with the front end of the projection lens barrel, all is well. If not, then loosen nuts B B, Fig. 299 (four of them) and adjust nuts C C, Fig. 299 (four of them) until the rod is centered up and down and nut D, Fig. 299, until it is centered sidewise, after which tighten nuts B B down solidly.

NOTE.—It is possible to make a very good adjustment by merely centering the end of the rod in the aperture, but when it is centered with both the aperture and lens barrel we know it is exactly right.

OPERATION.—To strike an arc, turn the negative hand adjustment crank R until negative is raised sufficiently to make contact with the positive, whereupon immediately separate the carbons, thus forming the arc. Now lower the negative until proper arc length is reached as per Fig. 301. Unless the arc length varies considerably no further attention will be necessary during the running of the reel, but if one carbon burns faster than the other, then hand adjustment will be required to re-establish proper arc length as per Fig. 301.

Should the positive carbon regularly burn away either faster or more slowly than the negative then an adjustment of the ratchet and pawl, which control the rate of feed of the positive carbon, should be made. This may be accomplished by loosening lock nut on set screw T, Fig. 300. Should the positive carbon be feeding too slowly, a turn of the set screw T toward the right, or in a clockwise direction will cause the pawl to engage more of the teeth on the ratchet and in this way feed the positive carbon a greater distance for each revolution of the carriage. Should the positive carbon be feeding too rapidly, by turning screw T in a counter-clockwise direction, the reverse action from the above will take place. This pawl U, Fig. 300, should be adjusted until the proper rate of feed of the top carbon is established, after which lock nut on set screw T should be tightened. If this lock nut on set screw T should become loose, set screw T may be turned out of its correct position by the pressure applied to feed ratchet and pawl U during the operation of the lamp.

SHOULD THE POSITIVE CARBON AT ANY TIME FAIL TO FEED examine the ratchet and pawl adjustment and make sure that at each revolution of the carriage the ratchet engages with the pawl and that the ratchet is turned.

Should this not be at fault, examine clamp E, making sure that the carbon is gripped tight enough to force it forward against the pressure of the contact shoe.

NOTE.—Hand adjustment knob Q and crank R will work hard when turned by hand because to turn them you must overcome friction of clutches S, Fig. 300, and cause them to slip against the pressure of the tension springs thereon.

LAMPS IN SERIES.—High intensity lamps may be operated from a series type motor generator, exactly as are the ordinary projection arc lamps. The procedure, wiring, etc., is exactly the same.

HIGH TENSITY A. C. OPERATION.—In case of emergency the G. E. High tensity lamp may be operated on A. C. In case your D. C. current supply should from any cause fail, first, since the lamp motor is a D. C. motor, disconnect it from all current supply. You may then connect the lamp to A. C. supply, either through an inductor, economizer, A .C. compensarc or any other similar low voltage transformer or through a suitable rheostat using the same carbons if the A. C. operation is to continue for but a few moments. If, however, you are to use A. C. for more than a few moments, then install a short high tensity positive carbon instead of the regular high intensity negative.

CAUTION.—Do not use the full rated D. C. amperage of A. C.. About ¾ the rated D. C. amperage is as much as you should use of A. C. which means that a lamp rated at 75 amperes D. C. should only be allowed 60 to 65 amperes A. C.

KEEP CLEAN.—Both the positive contact shoes H and also the opening in the asbestos baffle plate, directly behind them, should be kept clean and free from carbon dust. The contact surfaces on the positive contact shoes should be inspected every day. This may be done in the following manner:

Remove the screw holding the flexible metal ribbons, 5, Fig. 300, to the positive terminals, after which separate the arms sufficiently to release the coil spring and the entire positive shoe assembly can be lifted off the studs supporting it and thoroughly cleaned. The opening in the asbestos baffle plate should be kept clear and free from carbon particles.

The negative assembly does not require a great amount of attention, although care should be taken that the opening in the asbestos baffle plate G, Figs. 299 and 300, be kept clean and open so that the carbon may pass freely without binding. Care should also be taken that the negative carbon clamp F makes good contact with the carbon at all times.

EXAMINE TENSION.—Examine tension of positive current carrying contact shoes at least once, and preferably twice, a day. Tension must be sufficient to give firm contact and prevent arcing between carbons and clamp. Excess tension puts unnecessary strain on the motor and the carbon feeding mechanism; also it compels you to set clamp E unnecessarily tight.

THE MOTOR.—Motor brushes should be inspected at least every month; every two weeks, would be better. Use a good grade of machine oil in motor cups.

SPARE PARTS.—To guard against possible trouble and vexation, we would advise the projectionist to carry in stock the following spare parts: One positive contact shoe assembly, complete, shown at H, Fig. 300, for each lamp. One positive carbon clamp, shown at E, Fig. 300, for each lamp. One negative carbon clamp, shown at F, Fig. 300, for each lamp. One flexible wire jumper, shown at 3, Fig. 300, for each lamp. An extra pair of motor commutator brushes, for each lamp.

These parts are not expensive and they will be in the nature of insurance against possible trouble.

YOU WANT GOOD PAY DON'T YOU? WELL, THEN GIVE GOOD SERVICE—THE BEST THERE IS IN YOU

POWERS IMPROVED HIGH INTENSITY LAMP.—The Powers Division of the International Projector Corporation has taken over the manufacture of the General Electric High Intensity Arc Lamp, described on pages 790 to 797, under a special licensing agreement. Many improvements have been made on the lamp, which is now a genuine Powers product, called the Powers Improved High Intensity Lamp.

Basically the improved lamp is the same as the one described pages 790 to 797, and the description and instructions there printed apply broadly to both lamps.

However, the improvements are important, see figures 303, 304 and 305, hence a descripion of them is necessary, as well as amended instructions covering them.

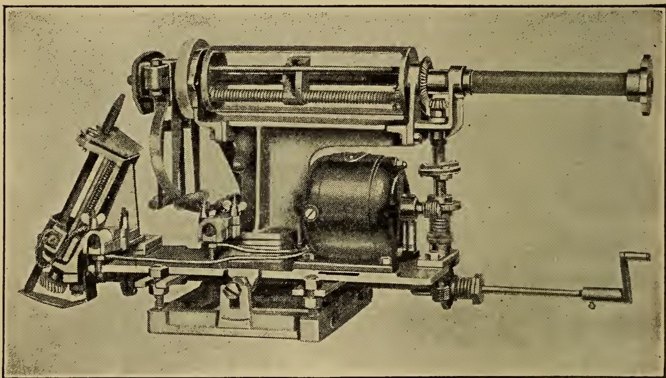


Figure 303

The positive contacts of the new lamp, instead of being made of a solid piece of metal as heretofore, now consist of two heavy contact blocks, HT-52, Fig. 304, each of which is held in a stamped sheet metal holding arm, Fig. HT-56. The contact blocks are readily removable from the holding arms. When worn out they can be replaced at a moderate cost. Instead of a single compression spring at the lower end of the contact arms, formerly used on the G. E. lamp, two compression springs, HT-204, Fig. 304, are provided so as to evenly distribute the pressure of the blocks against the positive carbon along their entire contact surfaces. The current is conducted directly from the positive carbon clamp to the contact blocks

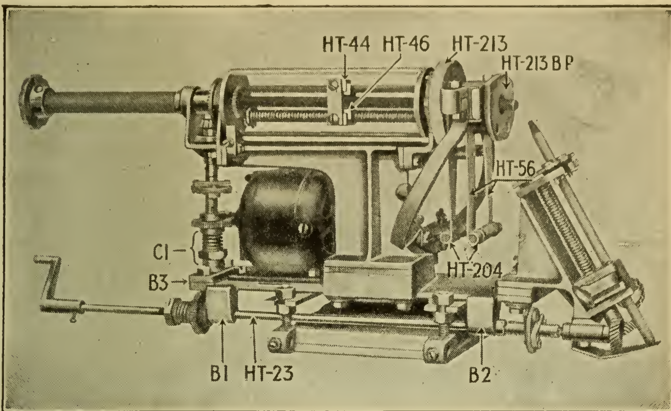


Figure 304

by means of flexible metal ribbon conductors HT-50 Fig. 305, which are attached to the contact blocks by means of wedge-shaped clamping blocks, Fig. HT-52 A Fig. 305, secured by screws HT-52 S Fig. 305.

To prevent rapid deterioration of the contact blocks from the high temperature of the arc, the lamp is provided with metal baffle plate, HT-213 BP Fig. 304, which is held in place by machine screws (two of them), HT-213 S. The baffle plate attaches to the two metal studs which extend out from asbestos guide plate HT-213 Fig. 304, which same support the positive contact arms.

The baffle plate is of special heat resisting metal. It has been found that after two hours of continuous operation, while the baffle plate became red hot, the contact block temperature was well within the limits of safety from damage by heat.

Another important improvement is the change in motor location. It now is mounted on the base plate of the lamp, where it is accessible for oiling, etc. The positive friction clutch has been located above the base plate, C-1 Fig. 304, where it is more accessible than formerly for adjustment.

The positive and negative feed shafts have been so arranged that the drive on the negative shaft is parallel with the face and the edge of the base plate, while the positive feed shaft is parallel with the vertical alignment of the lamp. The feed shaft negative bearings, B1-B2 Fig. 304, are integral with the base plate, eliminating the support bearing brackets used on the G. E. type lamp, and the lower bearing of the positive feed shaft, B-3 Fig. 304, is fastened to the upper side of the base plate, so that it is readily removable without the necessity of knowing the lamp from the lamphouse. The new feed shaft bearing construction insures perfect alignment of the positive and negative feed shafts in their respective bearings, and considerably reduces the load on the motor.

The negative bevel pinions which were formerly used on the G. E. lamp to transmit the movement of the negative feed shaft to the negative feed screw, have been replaced with two helical gears, HT-26 Fig. 305. The new helical gears, because of their more generous size and the greater mechanical efficiency of this type of gear, will be found to have much better wearing qualities than the bevel pinions, heretofore used.

The design of the positive and negative carbon clamps had been changed. They are now so constructed that any size carbon may be used within the limits of sizes manufactured for the purpose. To illustrate: If the lamp has been operating at 75 amperes and it is desired to use 100 to 120 amperes, it is merely necessary to remove an insert from the positive carbon clamp, replacing it with a different size insert, in order to use a larger carbon. The negative carbon clamp rests in a V shaped slot and no change in this clamp is necessary when changing from a small to a larger size carbon. The negative carbon clamp, HT-29 Fig. 305, is provided with a hinged clamping block, HT-30 Fig. 305, on which pressure is applied by means of the thumb screw, HT-30 S Fig. 305. This thumb screw is easily tightened or loosened by gripping it with a pair of gas pliers and giving it a slight turn.

The negative pigtail connector which was used on the G. E. lamp to conduct the current from the negative cable clamp to the negative carbon clamp has been replaced with a number of crimped copper ribbon connectors, HT-294A Fig. 305. This change was made to eliminate the frequent trouble experienced with the pigtail connectors breaking off at a point where they enter the two lugs which fasten them to the lamp at each end. The new type of crimped ribbon connector is designed to stand up under the continuous bending action due to the up and down movement of the negative carbon clamp.

Another change on the Power's Improved lamp from the G. E. type lamp is the new location of the detent spring, which is now placed on the right hand, or working side of the lamp, so as to make the detent adjusting screw, more accessible to the projectionist when he desires to adjust the rate of the positive carbon feed.

The instructions pages 794 to 797 for the care, operation

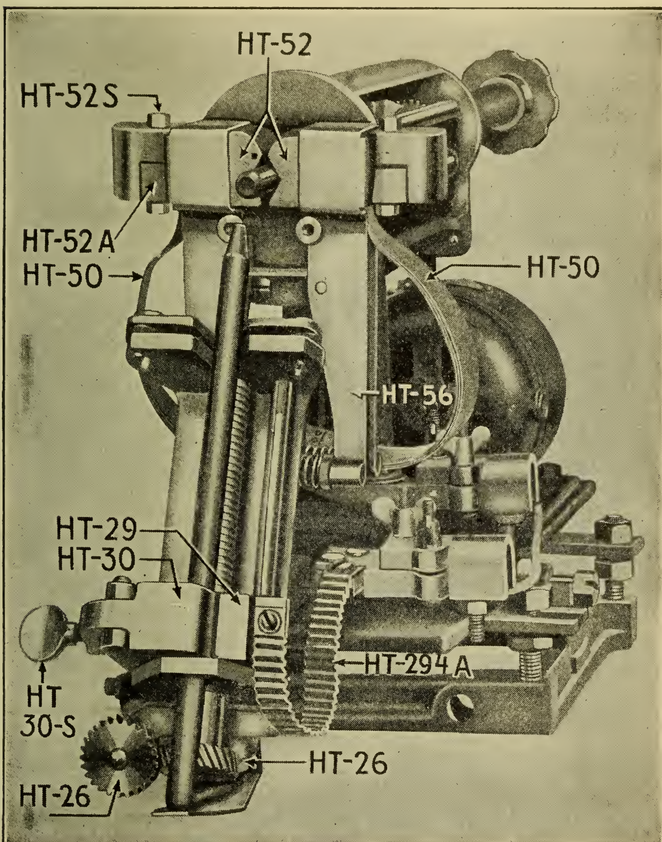


Figure 305

and adjustment of the G. E. lamp apply equally to the Power's improved lamp. Mention might be made here, however, of the method for removing the positive contact blocks from the sheet metal holders for the purpose of cleaning or replacing these blocks. To remove the contact blocks, take out the two compression springs, HT-204 Fig. 304, and bring the lower ends of the sheet metal contact block holders, HT-56 (Fig. 305, together at their lower ends, which will disengage the upper ends from the supporting pins. Once the holders are free from the supporting pins the connecting link adjoining the two holders can be removed, though each holder will still be connected to the lamp by the contact ribbon attached to the contact blocks. To remove this ribbon, take out the contact block clamping bolts, HT-52 S Fig. 305, remove the ribbon clamping block, HT-52 A, and the end of the contact ribbon will then be free from the block, which block may now be pulled out of the sheet metal holder and new block inserted, following the reverse procedure for reassembling to the lamp.

OPTICAL SYSTEM AND CRATER DISTANCE.—The optical system to be used and the principal constants are as follows: Condenser combination should be a 6½ inch focal length plano-convex collector lens and a 9 or 9½ inch focal length plano convex converging lens, the latter preferably five (5) inches in diameter. The collector lens should have the standard diameter of 4½ inches. Condenser lenses should be placed with their convex surfaces together and as close together as is possible without actual contact. A screw adjustment is provided for spacing.

NOTE.—The foregoing is manufacturers recommendation, with which we do NOT agree. We recommend that Griffiths lens chart be used, which may be done by adding one inch to the crater distances therein supplied.

The condensing lens mount as a unit should also be adjustable vertically and laterally, in order that the condensers may be properly placed on the optical axis, and the spot properly focused upon the aperture plate. The lamp should be mounted so that the center of the positive carbon is parallel to and exactly upon the optical axis, after which the lamp should be locked in this position, and the only adjustment then necessary is one through which the lamp may be moved laterally to and from the plano surface of the collector lens.

INTERCHANGEABILITY OF PARTS.—The positive contact holders and ribbons used in the Power's Improved lamp can also be used on the G. E. lamps now in service, therefore the solid nickel contacts formerly manufactured by the General Electric Company will no longer be supplied.

The new positive baffle plate can also be used on the G. E. lamps by removing the positive asbestos guide plate and replacing it with the positive guide plate, having the studs drilled out and tapped to receive the screws holding the new style positive baffle plate. When this change is made on the G. E. lamp, the life of the positive contacts will be greatly prolonged.

The negative pigtail connector used on the G. E. lamp can also be readily replaced with the new type of negative crimped ribbon connector heretofore described above.

In addition to the parts mentioned above, the following parts are also common to both the Power's Improved Lamp and the G. E. lamp:

Positive and negative feed clutch parts.
Worms and worm gears.
Positive drive bevel pinion and gear.
Spur gear on positive feed tube.
Spur gear and starwheel on positive feed screw.
Detent bracket and spring.
Insulated coupling on feed shafts.
Positive and negative cable clamps.
Front bearing support for positive revolving carriage.
Negative feed crank.
Positive feed knob.
Motor.

The following parts used on the Power's improved Lamp cannot be used on the G. E. Lamp:

Positive and negative carbon clamps.
Positive feed screw.
Positive carbon carriage assembly.
Rear bearing support for positive carbon carriage.
Negative support casting.
Negative drive gears.
Base plate.

Such parts of the G. E. type lamp which cannot be replaced with corresponding parts used on the Power's Improved lamp will continue to be supplied. Such parts will be manufactured in the factory of the International Projector Corporation and will be accurately machined from fixtures and jigs so that as far as possible they will be interchangeable with the parts formerly manufactured by the General Electric Company. This will eliminate to a large extent the special fitting of such parts by the projectionist in assembling them to the lamp as has been necessary in a number of cases in the past. All parts for the Power's Improved Lamp will be universally interchangeable.

When ordering repair parts it will be necessary to state whether they are intended for a high intensity lamp of the G. E. manufacture, or for the Power's improved lamp. If the former, then the ampere rating of the lamp should be given. It is also advisable in every case to state the serial number, which will be found on the name plate attached to the positive support casting.

THE ASHCRAFT AUTOMATIC ARC LAMP.—This equipment is made by the Ashcraft Automatic Arc Co. of Los Angeles, California. An examination of the photographs show it to be ruggedly constructed. It is a lamp built along the general lines of the high intensity lamps with which we are now quite familiar. It employs the same principles of operation.

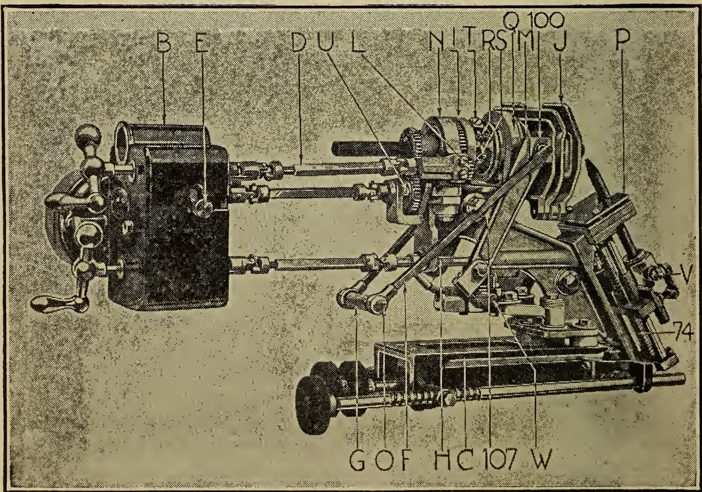


Figure 305A
The Ashcraft Lamp

There are, however, two important points of difference between the Ashcraft and the straight high intensity lamps, viz: (A) The Ashcraft lamp rotates its positive electrode by means of a motor which performs this function, and at the same time feeds the carbons forward as they burn away, but the carbon only revolves approximately two times per minute, whereas the usual high intensity lamps all use a much higher speed of rotation. (B) The regular high intensity lamps all use high intensity carbons exclusively, whereas the Ashcraft lamp may use, in cases where the current does not exceed 95 amperes, what is known as the "white flame" carbon. This carbon has a diameter of one-half inch. Its composition is of such a nature that it operates as a high intensity carbon, viz: It is sufficiently soft that a deep, symmetrical crater is formed, in which the brilliant high intensity gaseous ball of flame is contained. The crater area is slightly greater than that of the corresponding high intensity carbon, thus presenting a larger surface area to the collector lens. The 11 m/m carbon may also be used for the 80 ampere type, but in excess of 95 amperes the manufacturer recommends the regular 13.6 m/m only. The lamp illustrated shows the 120 ampere type, with the heavy cast alloy positive baffle plates.

Until recently these lamps have only been in use in the West, hence we have not had an opportunity to personally examine their performance. We therefore set forth only the manufacturer's claims. However, there can be no doubt but that the lamp gives excellent results, because it has climbed rapidly into popularity in the West in territories where high grade projection is the rule. Reports of the lamp from West Coast projectionists are excellent. It is for these reasons it has been admitted to the Bluebook, where only equipment which we have good reason to believe, or which we personally know to be high grade, is admitted.

The manufacturer does not recommend the use of the high intensity carbon in theatres where the current used does not exceed 95 amperes, as the claim is made that a softer, and at the same time very brilliant screen illumination results from the use of the white flame carbon without the objectionable harshness of the high intensity light; also that the screen briliancy is very satisfactory even in cases where demands for extremely high screen illumination are made by the projectionist or exhibitor.

One peculiarity of the Ashcraft lamp is that instead of the carbon rotating element gripping the carbon well back from

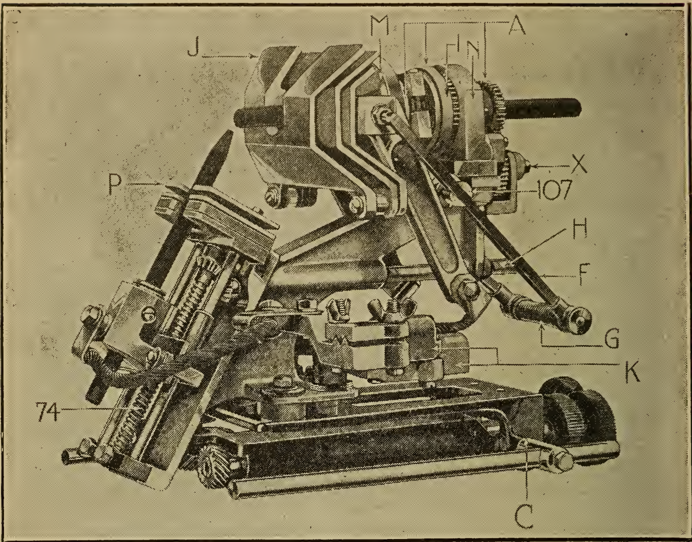


Figure 306A
The Complete Ashcraft Unit

the arc end of the carbon the gripping is done quite close to the front end.

This arrangement has two distinct advantages. It causes the current to enter the carbon near the point at which it will be used, thus minimizing the heating effect. In conjunction with baffle plates J. Figure 306A it prevents the crater of a carbon which is not perfectly straight from gyrating. The rear end of the carbon being entirely free, it can and does gyrate (wabble) if the carbon be not perfectly straight, but that does no harm.

The positive contact shoes, 100, figure 305A, slip into a slot machined through the positive nose, M, figure 306A. They are made from a cold-rolled alloy. The tension arms, F, figures 305A, pass down obliquely, and are pivoted at 107, figure 306A as shown. There are two of these arms, one on either side. At their upper ends they each bear on one-half of the split contact shoe through which the carbon passes. Between their lower ends as shown at G, figure 306A and G is a coil spring, which holds the ends apart under pressure, thus pressing the upper ends together with the two halves of the contact shoes, into contact with the carbon, though not with sufficient pressure to prevent its rotating and sliding ahead as the carbon burns away at the arc. The spring is, it will be observed, well removed from the heat of the arc, and should retain its temper indefinitely. Means for adjustment of this spring is provided for by an adjusting screw at its end, 305A. Heavy bus bars and terminal clamps are provided, K, figure 306A, so that in case of emergency where it may be necessary to form a new connection, such as burning off of leads, etc. A new connection may be made quickly and without interruption to service.

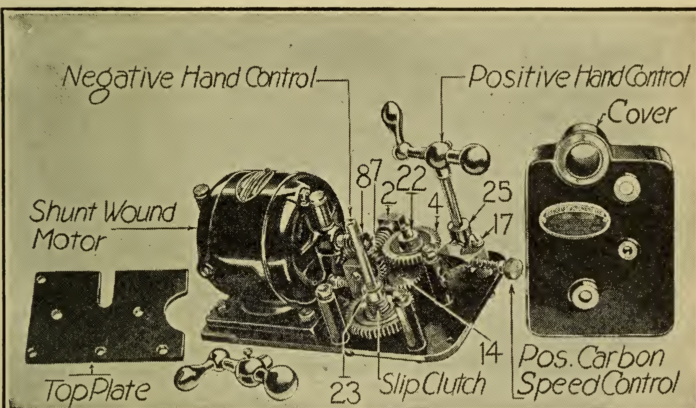


Figure 307A
View of Arc Controller, parts exposed.

The arc controller is connected to the lamp by means of insulating telescopic rods D, Fig. 305A. The controller is mounted on the back of the lamp house, as is seen in Fig. 308A The motor of the controller is connected across the arc and operates on the well understood arc voltage principle, in conjunction with mechanical control of the positive carbon feed. So far as is possible, all gearing of the controller is enclosed in a metal casing, with which the entire controller, except the motor, is covered, thus protecting it from the dust, etcetra.

The lamp consists of four main elements, viz.: (A) The positive rotating head, the positive nose, the negative feed assembly and the main frame. (B) The arc controller, which is mounted on the back of the lamp house. (C) An adjustable base which permits of moving the lamp up, down, sideways, backward or forward by means of suitable controls located outside the lamphouse. (D) The insulating telescopic rods by means of which the arc controller is connected with the carbon rotating and feed controls.

The function of the positive rotating head A, Fig. 306A which is carried on the ball bearing, enclosed in housing N, Fig. 306A, is to give the positive carbon a rotary motion, and at the same time feed it forward as it burns away at the arc. Rotary motion of the positive head is produced by driving gear U, Fig. 305A, which is connected to and rotated by shaft 22 in the arc control, Fig. 307A. It is connected thereto by the center telescoping rod, as shown in Fig. 305A.

The carbon is fed forward, as it burns away at the arc, by means of two feed rollers, one of which is shown at R, Fig. 305A There is another similar one on the opposite side of the carbon. These rollers are grooved in the center, and present sharp gripping edges to the carbon. They are mounted on separate shafts. One end of each of these shafts is fastened to a block through which passes a screw, T, Fig. 305A, which connects the two together and provides adjustment of the pressure of feed rollers, R, upon the carbon. The two blocks and adjusting screw are plainly shown in Fig. 305A. The other ends of these shafts are connected by means of a spiral spring, under tension, S, Fig. 305A. This spring, as will be seen, holds the feed rollers R against the sides of the carbon, under pressure which may be regulated by means of adjusting screw, T, Fig. 305A.

The teeth of gears R, besides being held in contact with the carbon, also mesh with a flat spiral groove, or scroll, machined in the face of part, I, Fig. 306A. Part I is loosely journaled upon part A, and if not held by some means, rotates with gears R. The means provided for holding it are by a pawl and ratchet located in the arc control as shown at 25, Fig. 307A. This ratchet acts four times during each revolution of the positive head, thus causing the part I to stop four times also. As soon as part I stops rotating, feed rollers R, which are always rotating about the axis of the carbon, also rotate upon their shafts, thus forcing the carbon forward until part I is released by the action of the pawl in the arc controller, and allowed to rotate with gears R. When scroll I rotates with gears R, no forward motion is given to the carbon. The feeding of the carbon forward is therefore positive, and fairly continuous. After adjustment of forward feed is made to suit the current used (which will be explained later) there is very little alteration required. Hand feeding is accomplished by pushing in on the hand control handles, which releases the automatic, and permits rotating of the feed handle, counter clockwise for forward and clockwise for backward motion of the carbon. To re-carbon the positive, all it is necessary to do is to insert the new carbon in the rear end of the tube, forcing the used one out of the front end. The rollers then seize the carbon. No resetting of the carbon is necessary.

The positive "nose" is composed of the carrying standard upon which is mounted the heat resisting alloy casting, M, figures 305A and 306A. The casting is insulated from the standard by means of the transite plate Q, Fig. 305A. A groove ⅞ inch square is machined in nose M, Fig. 305A and 306A into which the contact shoes, 100, Fig. 305A, are placed. These shoes are of cold-rolled alloy, with one surface milled to fit the carbon. The shoe castings extend downward and backward, and at their lower ends are connected to the positive bus bar by flexible lead W, Fig. 305A. This connection is placed well out of the heat, and should last indefinitely. The contact shoes, 100, Fig. 305A, are held in firm contact wiith the carbon by means of arms F, Figs. 305A and 306A, the lower ends of which are pressed apart by means of a coil spring located between their ends at G, Fig. 305A. The effect of the pressure of this spring, which is far removed from high temperature, is to cause the upper ends of the arms to press the two halves of the contact shoes together, and thus grasp the carbon.

TENSION ARMS INSULATED.—The left hand tension arm, F, Fig. 305A, is insulated at its lower end, at the point at which the spring makes contact, for the purpose of stopping a flow of current from one brush to the other through spring G. This current, if allowed to pass through the spring, would cause it to gradually weaken.

By this arrangement of the contact shoes the current is conducted into the carbon very close to the arc, and practically all carbon resistance is eliminated.

WARNING.—The pressure of spring G must be sufficient to insure good electrical contact between the contact shoes and the carbon, but not sufficient to stop rotation of the carbon, and its feeding forward, which must be done against the friction set up between the carbon and contact shoes by spring G, acting through the tension arms F. Adjustment of spring G is readily made by means of screw O, Fig. 305A.

Baffle plates J, Figs. 305A and 306A, is fastened to the front end of the nose casting M, Figs. 305A and 306A. The rear baffle serves to hold the brushes in their slot and, in conjunction with the other two, provide a protection for the entire mechanish against the heat of the arc. The lamp illustrated is of the 125 ampere type, in which the baffles are cast from a non-corrosive alloy, with the front baffle insulated from the rear ones, which prevents the arc from making electrical contact through them and burning them. Air spaces are provided between the baffles, to allow of rapid heat dissipation.

NEGATIVE ASSEMBLY.—The negative assembly is fed upward by screw 74, Figs. 305A and 306A, carrying the negative carbon with it, of course, by means of shaft H, Fig. 305A, and the gearing at its front end. Shaft H connects to shaft 23 in the arc control by means of an insulating telescopic rod. The negative carbon may be independently advanced or retarded by means of control handles mounted on shaft 23, Fig. 307A. It is only necessary to press in on the handle to disengage it from the gearing. There is a slip-clutch provided on shaft 23, shown in Fig. 307A, so that in case the negative carbon carrier jams at the top, due to too-short burning of the carbon, there will be no damage done to the apparatus.

ARC CONTROLLER.—The arc controller consists of a shunt wound motor which is connected across the arc, hence operates on arc voltage. The motor rotates the positive carbon at a constant speed through shaft X, Fig. 306A, and the negative feed screw through shaft H, Fig. 305A. The motor shaft connects to the driving shafts 22 and 23, Fig. 307A, through a train of worm gears which reduce the speed of motion to the proper value.

ADJUSTABLE BASE.—The lamp is mounted upon and insulated from base C, Figs. 305A and 306A, which is made in two parts, the lower part attaching to the lamphouse slide rods of any standard professional projector. The make of projector must, of course, be known, so that the proper base may be provided. Upon this lower base, and hinged thereto at its rear end, is a second base, to which the lamp is attached. This upper base may be moved sideways, thus providing sideways movement to the lamp as a whole. Its front end may also be raised or lowered by means of a screw, actuated through spiral gears, by means of a control handle located outside the lamphouse. Forward and backward motion is also given to the entire base by means of a screw mounted on lamphouse base and passing through adjustable base.

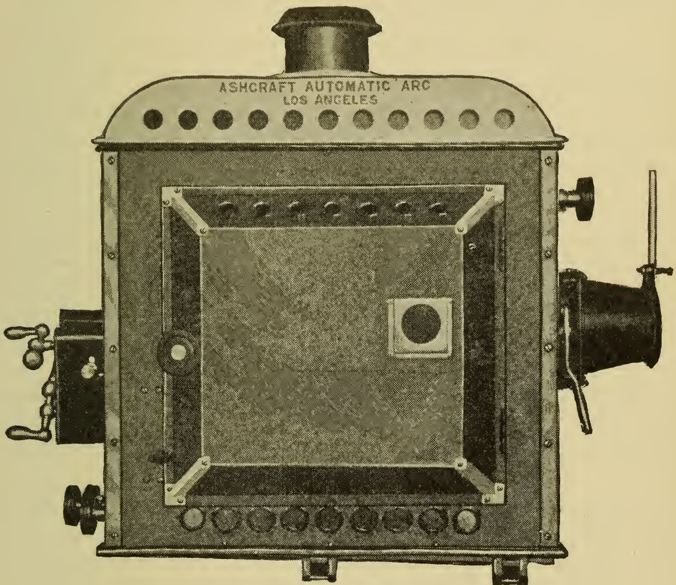


Figure 308A
Ashcraft Lamphouse.

The lamphouse which is an integral part of the equipment, is of heavy sheet metal, with reinforced double doors. The dimensions are: Length, 20 inches. Width, 11¾ inches. Height, 22 inches. The lamphouse has a removable top for cleaning. Ports for cleaning are also provided at the front end. The entire lamphouse is finished in black enamel, with nickel trim. The vent flue is 4 inches in diameter.

CARE OF THE LAMP AND ARC CONTROLLER.—Oil at points 2-22-25-17-14-23, Fig. 307A. Fill groove in gear 7 with oil. Keep gears 4 and 8, Fig. 307A, lubricated with good grade of light grease, and keep motor bearing cups filled with a good grade of vaseline.

THE LAMP.—If rollers on scroll gear work too hard, put a very small amount of good graphite on the teeth. The burner should never be oiled. For it the manufacturer recommends a graphite lubricant only. Those parts exposed to extreme heat require but very little lubrication of any kind.

IMPORTANT.—The positive contact shoes must be cleaned once every day at the point of contact between them and the carbon. Also be sure that the shoes are free in the slot. Give the spring which provides tension to the contact shoes frequent attention. The spring must exert sufficient force to provide good contact between the shoes and the carbon, but not enough to bind the carbon so hard that rotation is difficult, or is stopped entirely.

To clean the positive contact shoes, press the tension arms at their lower ends, at the same time pressing downward. The contact shoes may then be removed from the slot. An iron rod 7/16 inch in diameter, of suitable length, wrapped with fine emery cloth is an excellent tool for cleaning the contact shoes.

IMPROPER FEEDING.—In case the positive carbon does not feed properly, either the screw, T, Fig. 2, connecting the feed rollers, R, Fig. 2, needs tightening or spring, G, at lower ends of tension arms should exert less pressure.

ADJUSTING RATE OF FEED OF POSITIVE CARBON. In Fig. 307A is shown the adjusting screw for regulating the forward feed of the positive carbon. Screwing this adjustment in, or clockwise rotation, slows down the carbon feed. Screwing out, or counter clockwise rotation, speeds it up.

SPARE PARTS.—The manufacturer recommends that an extra set of contact shoes, 100, Fig, 2, and positive and negative leads be kept on hand.

THE "HC" HIGH INTENSITY ARC LAMP is the later development of the old Sperry High Intensity Lamp. It is now handled by the Simplex Division of the International Projection Corporation, and is a part of the special equipment provided, upon order, with the Simplex projector, or it is sold separately for installation on any make of projector. It is well made and an efficient piece of apparatus.

GENERAL DESCRIPTION.—The HC lamp and its controlling mechanism is mounted upon a universally adjustable carriage, which rests upon a suitable base forming the floor of the lamphouse. This carriage may, together with the light source, be raised or lowered, shifted in either direction sidewise or moved backward or forward with relation to the condenser lens. These various movements are accomplished by means of suitable control rods, terminating in the usual knobs at the outside of the real lamphouse wall.

The feeding of the carbons is controlled by long, coarse-threaded shafts or spinales, so located that they are not subjected to high temperature.

The forward end of the positive carbon is clamped by a current carrying "floating" carbon contacter head, the term "floating" meaning that it is not a positive clamp, but one controlled by spring tension—the pressure between the metal of the contactor and the carbon being dependent entirely upon spring action. This is done in order to supply good electrical contact without binding the carbon, which must be rotated and shoved forward through the contactor head constantly during the whole time the arc is in operation.

The negative carbon is clamped in a V-shape slot in a carriage which moves up or down at an angle of 40 degrees with the axis of the projector optical train. This was found to be the angle making for most efficient results. The arrangement is such that "penceling" or "needling" of the negative carbon is reduced to a minimum.

The lamp is so designed that positive carbons twenty (20) inches in length may be used, and nine inches of this length may be consumed without altering the setting of the positive clamp, located back some distance from the floating contactor head before described. The entire negative is burned with no change in its setting. This provides for a possible continuous run of thirty-two (32) minutes with no change in the carbon setting, after which a new negative must be installed and the positive clamp of the positive carbon loosened, the carriage pulled back, the carbon shoved forward and the clamp re-tightened.

HEAT SHIELD.—A heat shield of pure nickel is provided in front of the positive contactor head. This metal has high heat resisting qualities. It protects the positive contactor head, and may be readily removed for replacement when that becomes necessary.

THE ARC CONTROLLER.—The carbon feeding mechanism is semi-automatically controlled through variation in the arc voltage caused by variation in arc length as the carbon is consumed. The motor driving the controller is connected "across the arc" (is in shunt series therewith) through a potentimeter resistance. The motor is geared to the carbon feeding mechanism by means of gears and chains. The positive and negative carbon feeding mechanisms are independent of each other. The positive carbon is rotated and fed forward, and the negative is fed forward by means of pawl carriage, pawls and ratchets, driven by the main controller chains and sprockets. These pawls and ratchets are so arranged that the rate of feeding of either the positive or negative carbon may be altered by causing their pawls to engage either every tooth, every alternate tooth or every third tooth of their respective ratchet wheel each time they act. Also the speed of the driving motor may be altered in infinitely small steps by means of the potentiometer rheostat conveniently mounted on the back wall of the lamphouse.

OPERATION AND CARE OF THE LAMP.—It is possible, in emergency, to disconnect the arc controller, the motor of which is a D. C. unit, feed the carbons by hand and use A. C. direct from the line, through a suitable resistance or transformer of course. The results will, by comparison, be very poor, but you can "get by" in emergency.

IMPORTANT.—It is very important that high intensity carbons be operated at a very close approximation of their rated capacity. Too much current will blow the gas out of the crater, while too little will cause a rapid falling off in efficiency. You may use either 120, 75 or 50 ampere carbons, but whichever you use, use their amperage rating, and if you want high grade results DON'T GUESS AT IT, OR DEPEND UPON ANYTHING BUT A RELIABLE AMMETER.

Don't make the mistake of imagining that because a rheostat is rated at a certain amperage at its various steps (in adjustable), because in all human probability it won't do anything of the sort. Very likely the actual current it delivers will not be anywhere near its official "rating." This is because whereas new resistance wire which will pass say twenty-five amperes of current on a certain voltage pressure, very likely won't pass more than eighteen or twenty in a month's time. The resistance for a considerable time rises with use; also fluctuations in line voltage alter amperage delivery through a rheostat, and every change in arc length alters the amperage flow as well.

CARBONS. IMPORTANT.—If you expect to get satisfactory results, use high grade carbons. There are many good brands upon the market, but the Simplex Division of the International Projector Corporation recommends the Columbia White Flame High Intensity carbon as satisfactory. They should be used with Silver Tip cored and coated negatives. The correct carbon diameters are as follows:

120	Amperes	13.6 mm. White Flame High Intensity Carbons
120	"	3/8 inch coated and cored negative
75	"	11 mm White Flame High Intensity Carbons
75	"	11/32 inch coated and cored negative
50	"	9 mm White Flame High Intensity Carbons
50	"	5/16 inch coated and cored negative.

CONDENSER.—It is recommended that you use the Griffith Lens Chart. The time for guess work in condenser combinations has passed. The focal length of condenser and distance face of collector lens to aperture depends upon projection lens working distance and diameter, and these various elements must be fitted to each other correctly, if you expect to get good results, and to get them efficiently.

ARC REGULATION.—The arc length is fixed at its most efficient length by the projectionist in the first place, and is thereafter automatically kept at that length by the arc regulator. The motor is very sensitive to variations in voltage, and since the arc is in shunt series with it, any raise in voltage caused by a slight lengthening of the arc gap, causes the motor to speed up, thus feeding the carbons faster.

To compensate for uneven consumption of the positive and negative carbons there is, in the HC arc controller, means for changing the ratio of the feeding of them. This is done by changing the adjustment of the operating pawls, so that they will engage every tooth, every second tooth or every third tooth of a ratchet wheel.

LUBRICATION.—Do not use ordinary oil or grease on the lamp. It will cake under heat, and may finally render the lamp mechanism entirely inoperative. The best lubricant of very fine graphite mixed with kerosene for all parts such as the carbon feeding worms, the positive carriage guide rod, the guide rods for the negative carbon holders and the various bearings of the lamp. WARNING.—In using graphite be very careful not to get any of it on the lamp insulation, as it is a conductor of electricity and you may thus form grounds, or cause arcing between parts of opposite polarity.

For the arc controller use a good grade of machine oil on moving parts and journals. In the motor worm gear casing use a good grade of cup grease.

CONTACTS.—Be certain that the surfaces of metal which contact with the positive carbon are clean, and that they remain so; also that they make good contact with the carbon. Make sure that all connections are tight, particularly the flexible strips connecting the positive carbon contacts with the lamp frame, and the shunt connecting the negative carriage to the negative guide head. The main terminal connections will need tightening up from time to time.

LINING UP THE LAMP.—It is very essential to good results that the carbons be properly lined up. When the lamp is trimmed, the center or axis of the negative must point exactly at the center of the positive carbon tip. If this is not the case, then the arc will burn unsteadily and there will be a noticeable flicker therein. The negative head is adjustable and the lining of carbons is accomplished as follows:

LINING THE CARBONS.—Loosen the two hexagon-head set screws which hold the negative head to the lamp frame, and move the head until the tip of the two carbons are exactly as above explained, and then retighten the set screws. By bringing the two tips very close to each other it is easy to tell when they are correctly centered with each other.

UNSTEADY ARC AND FLICKERING IN ARC may be caused by (a) Excessive current. (b) Arc too long. (c) Poor carbons. (d) Drafts or air currents caused by too strong or improper ventilation in lamphouse. (e) Carbons not in correct alignment with each other. (f) Positive carbon not extended far enough beyond heat shield. (g) Loose connections.

SPARE PARTS.—The manufacturer recommends that you carry at least one spare of such parts as are subject to deterioration, such as HC No. 3, HC No. 4, Positive and negative flexible shunts, HC No. 6 and HC No. 65.

THE REFLECTOR TYPE ARC LAMP

The reflector type arc lamp, which is a comparatively new addition to motion picture projection equipment in this country and Canada, by virtue of its merit has found much favor in the eyes of motion picture projectionists and exhibitors. This lamp was officially named the Reflector Arc Lamp by the Society of Motion Picture Engineers at its 1925 fall meeting, hence will hereafter be given that title in this book.

There seems to be little or no doubt that this type of lamp is destined to assume a very important position indeed in the field of motion picture projection. It therefore is not only advisable, but very necessary that motion picture projectionists become thoroughly familiar with the optical systems employed in lamps of this type, to the end that they be able to handle the equipment intelligently, and by so doing secure maximum results when called upon to use it.

The reflector arc lamp gives a great increase in screen illumination per unit of electric energy expended, as compared with the ordinary arc. This is chiefly due to three causes, Viz: (A) The greatly increased angle of light interception, because of the fact that the mirror which collects the light has much greater diameter than has the condenser employed in connection with the ordinary arc, and is curved instead of having a flat surface; also the distance of the light source from the vertex (center) of the mirror is considerably less than is the distance from crater of the ordinary arc to face of collector lens in ordinary practice. (B) The crater of the arc of the reflector type lamp is plane to the optical axis. In other words it faces the center of the mirror squarely, or very nearly so, whereas the crater of the ordinary arc cannot be made to operate well if it be less than a fifty-five degree angle from the optical axis, which means a thirty-five degree angle to the face of the collector lens, see figure 120B, page 407. (C) There is the further fact that the ordinary arc employs a 2-lens condenser, which means four surfaces, and since there is a minimum loss of about four per cent., see page 141, through reflection at each surface, there is a total, unavoidable minimum loss of sixteen per cent through reflection from surfaces in the plano convex condenser.

This, however, serious as it is, represents only the minimum loss through reflection at the lens surfaces when the surfaces are well polished and perfectly clean. As the lens surfaces become dirty, the loss increases progressively and very rapidly, in proportion to the amount and character of the deposit. It may, and sometimes in extreme cases does, amount to the enormous total of twenty-five per cent of the light incident upon the first surface of the collector lens.

To the loss through reflection above described must be added the further and considerable loss caused by the sharp angle of incidence at the outer zones of the collector lens, which is at its maximum when the light source is close to the lens. There is also a loss through light absorption which (see page 145) will hardly be less than .05 per cent per centimeter of thickness (One centimeter equals approximately three-eighths of an inch) and may be considerable more if the glass be of poor grade. This loss may be roughly placed at a total of about five to six per cent. Another loss which may or may not be present in individual installations, but usually is if the amperage is high, is that due to "pitting" of the face of the collector lens. Just what this loss is no one seems able to determine, but undoubtedly it is considerable where the pitting is bad. On top of all this enormous inefficiency must be added the tendency to discoloration found in plano convex condenser lenses, which are necessarily subject to very high temperature. Discoloration, however, apparently affects the quality or tone of the light, rather than operating to diminish its volume, and as a final there is the loss due to the angle, if any, of the light source to the face of the collector lens.

From the foregoing we see that the condenser system employed in conjunction with the ordinary arc light source for projection is very, very inefficient, and it is due to that fact that the reflector arc lamp, which employs an optical system either almost entirely free from (if properly handled) or at the worst having but a small fraction of the losses above described, is able to make an equal or even a better showing in light delivery when using only about one-third the electric power consumed by the ordinary arc.

ANGLES OF LIGHT.—Figure 309A is a diagrammatic illustration of the angle of light utilized from the ordinary arc light source working in conjunction with a plano-convex condenser, in which the collector lens has a free opening of 4.25 inches—which is about the average free diameter of such lenses in actual practice. In the illustration we see the light source located both at three inches and at four and one-half inches from the face of the collector lens. These two distances represent the extremes of crater distance under normal practice, though either of them may be exceeded under some conditions.

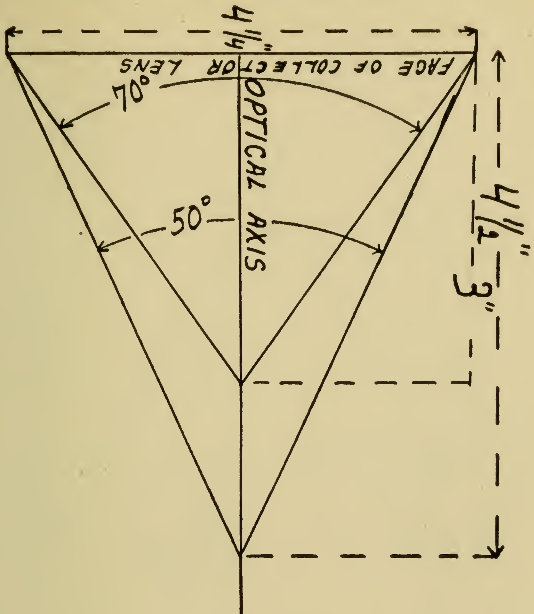


Figure 309A

You will observe that with the light source (We have merely used a point light source for illustration, disregarding the actual practical effect diameter the light source has, because it does not in any way alter the principle we seek to make clear) located three inches from the face of a collector lens having a free opening of 4¼ inches, approximately a 70 degree angle of light is collected and transmitted forward to the converging lens. This angle diminishes rapidly, however, as the light source is retarded, as shown in figure 309A, and when it, the light source, is 4.5 inches from the face of the lens, only an angle of 50 degrees enters the lens and is transmitted forward to the converging lens. In this connection, however, it must be noted that as the light source is retarded—moved away from the lens—the angle of incidence of the light rays with the face of the lens becomes less, and the loss by reflection is therefore reduced. This latter, however, amounts to comparatively little, except in cases where the light source is very close to the collector lens.

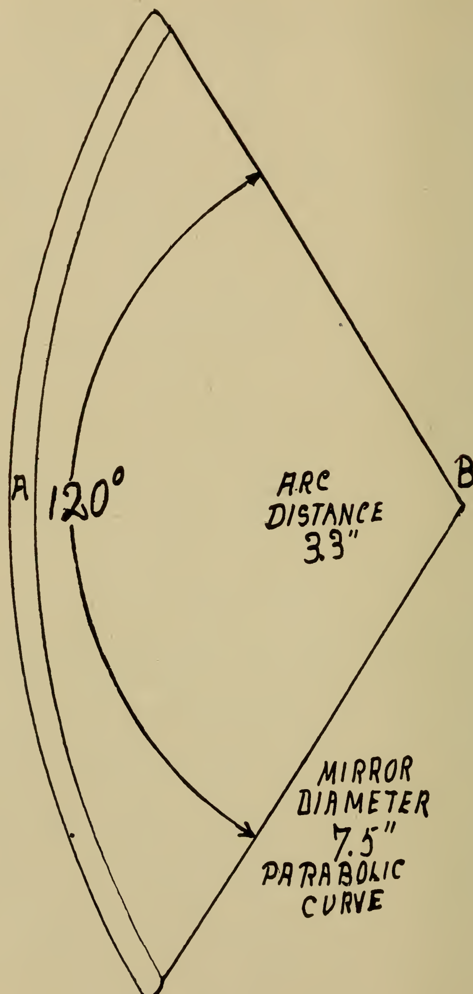


Figure 310A

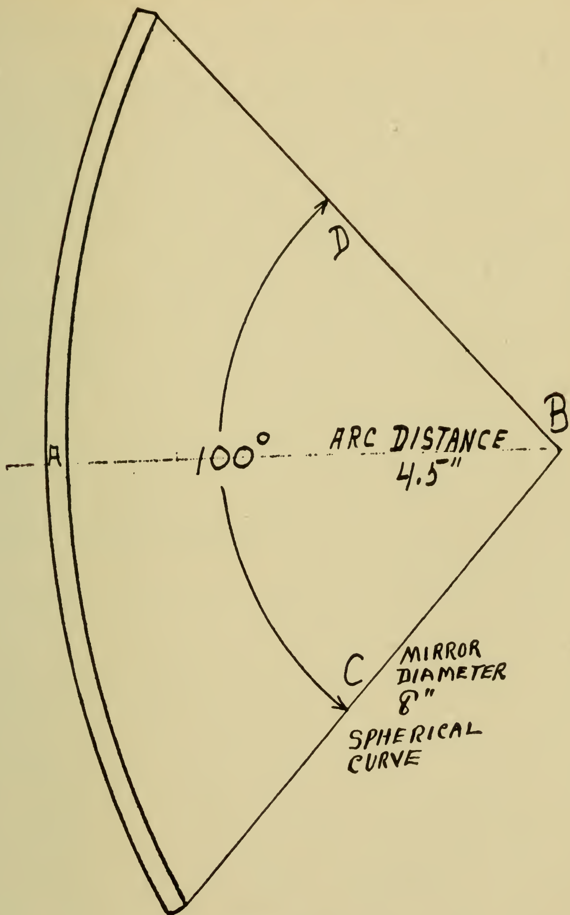


Figure 311A

Projectionists who may be inclined to doubt the correctness of these angles, may easily lay it out, to scale, on paper, and with an ordinary protractor, procurable at any stationery store which handles draughtmen's supplies, measure the angles for themselves. Of course all light falling outside this relatively small angle falls upon the walls of the lamphouse and is wasted.

On the other hand the reflector arc lamps employ a mirror having a curved surface. This operates to reduce the loss through reflection, as compared to the loss before mentioned due to the heavy angle at which the incident light meets the flat surface of the outer zones of the collector lens of the plano convex condenser. However, since the light is reflected back, there is an additional loss of about three per cent due to reflection, and another loss of about 4 per cent as it passes back through the outer surface of the mirror.

The total loss due to these various things, however, certainly will not equal the loss inherent in the collector lens alone, where either a plano convex condenser or Cinephor is used.

In figure 310A we have the diagrammatic representation of the 7.5 inch diameter parabolic mirror used in one type of reflector arc lamp which employs a condenser. **No attempt has been made to draw a parabolic curve.** Our only intent in this, and the other drawings of mirrors, is to show the arc distance and angle of light picked up by the mirror. We do not assert that the figures given as to angles of light are precise, but they are nevertheless correct within a very small margin either way.

In figure 310A you will observe that the arc distance from the vertex (center) of the mirror is 3.3 inches, and the angle of light picked up is 120 degrees.

In figures 311A and 312A we see the diagrammatic representation of two of the mirrors used by non-condenser types of reflector arc lamp. These mirrors are spherical, hence have spherical aberration, as has been noted. The line-up for the eight inch mirror is: Arc distance from vertex of mirror 4.5 inches. Distance vertex of mirror to aperture 22 inches. This mirror picks up an angle of light equal to 100 degrees. The smaller diameter mirror has an arc distance of only 3.75 inches, hence, although of much less diameter, it picks up an angle of light equal to 95 degrees, or only five degrees less than the eight inch mirror. We mention this as showing the relation to arc distance and mirror diameter.

It must, however, be remembered that either for a parallel or a converging mirror beam, the amount of spherical aberration is greater with short than with long focal length mirrors, except for mirrors of not more than six inches diameter. This is true because of the fact that up to six inches of the diameter all mirrors used for projection work are essentially spherical.

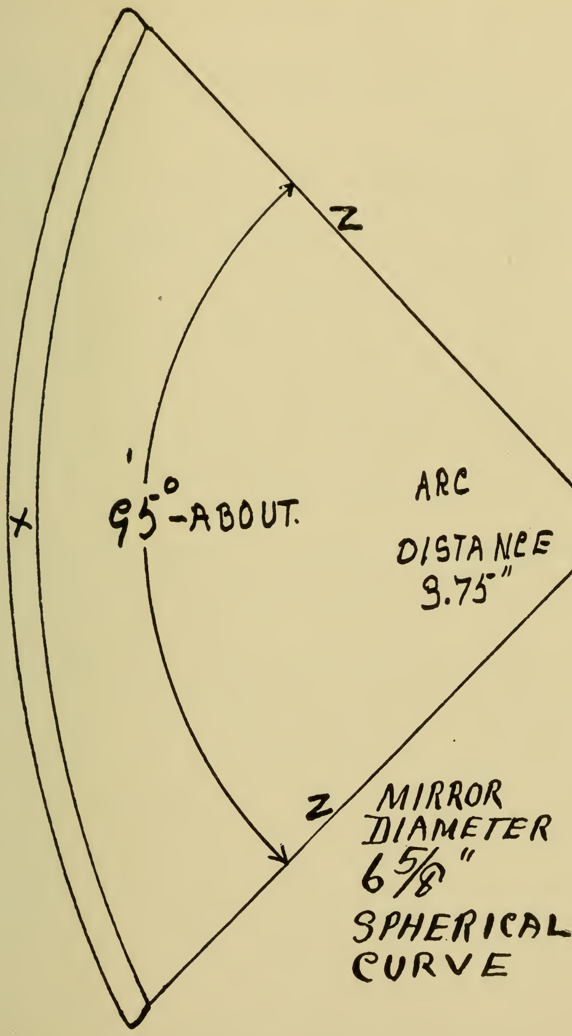

Z
X
95°-ABOUT.
ARC
Y
DISTANCE
9.75"
Z
MIRROR
DIAMETER
6 5/8"
SPHERICAL
CURVE

Figure 312A

In other words the central six inches of them all is either spherical or very nearly so.

For a parallel (non-converging) beam the parabolic mirror is best; for a converging beam the elliptical mirror serves the purpose best. The spherical mirror is merely a corrected mirror. See figure 314A.

POSSIBLE MAXIMUM ANGLE.—The maximum angle of light which it would be possible for a reflector to pick up, or intercept would, in theory, be 180 degrees, which would necessitate the use of a reflector making a complete half circle around the light source. As a matter of fact, however, the angle which could be used in practice would be somewhat less than this, because of the fact that little or no light actually leaves the crater in a direction at full right angles thereto.

Exhaustive tests have been made by Dr. Simon Henry and Dr. Henry Phelps Gage, and by the late Doctor Kellner, of the Bausch and Lomb Optical company, which same have proven that the maximum light angle any reflector can pick up and efficiently utilize in the form of a solid beam, is 120 degrees, hence the mirror shown in figure 310A may be said to be operating at the entire possible maximum of efficiency.

ABERRATIONS.—In reflector arc lamp optical systems two distinct types of reflector are used, Viz: the parabolic and the spherical. The spherical mirror is one the curve of which is the like circumference of a circle. In other words it is the section of the surface of a true sphere, the focal point of which is the center of the sphere. This is illustrated in figure 313A, in which D is the reflector, or mirror, A the focal point (center of curvature) of the mirror. From A to any point on the surface of the mirror is the measurement of the focal length of the mirror.

With such a mirror, were the light source placed at A (This would only be precisely true were the light source a "point," but this item is neglected, as we only seek to have you understand the principle), it would be exactly plane to every point on the mirror surface, under which condition there would be no spherical aberration at all, but the image of the light source would be focused directly upon the light source itself.

This would, of course be impossible for projection purposes, since the film must be illuminated by the light reflected from the mirror, hence the beam must not only be extended beyond point A, but also its cross section at the point it meets the

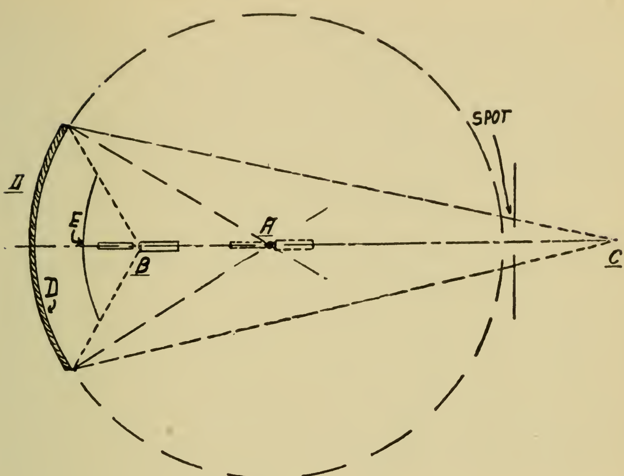


Figure 313A

film must have sufficient area to covei the projector aperture.

These two things may only be accomplished by advancing the light source toward the face of the mirror, as at B, figure 313A.

In doing this we secure magnification, extend the beam, and very greatly increase the angle of light the mirror intercepts; also in so doing we introduce the element of spherical aberration, so that the rays of light reflected by the outer zones of the mirror focus considerably nearer the mirror than do the light rays reflected from the more central zones. This is due, as we understand it, to the area of the light source. It cannot possibly be overcome, as it is a fault inherent in spherical mirrors when a light source having area is used at any other point than the true focal point of the mirror. In fact we believe it would not be entirely absent, even with the light source at the focal point, so long as the source had area.

The practical effect of this is to produce a certain amount of unevenness of screen illumination when spherical mirrors are used.

This fault may be corrected in apparatus employing a condenser by using a parabolic mirror, or when a non-condenser apparatus is used, by employing an elliptical mirror.

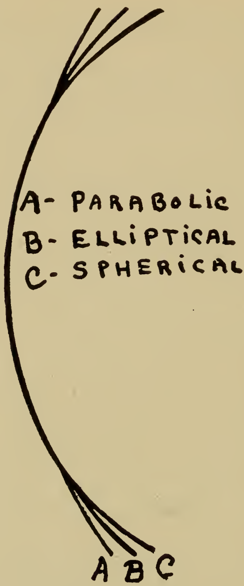


Figure 314A

In figure 314A we illustrate the difference between spherical, elliptical and parabolic mirrors.

EFFECT OF HOLE IN MIRROR.—While at first glance it might be assumed that the round opening in the center of the mirror through which the negative carbon passes would cause light loss, this is not true, because of the fact that, due to the tip of the negative carbon, little or no light could reach this part of the mirror, even though it were solid. The reason this dark spot does not show on the screen is very simple.

The face of the mirror is in focus out in front of (screen side of) the projection lens, as you may prove by affixing a bit of dark colored paper to the mirror surface and catching its image on a screen held the proper distance in front of the projection lens.

Due to this fact neither the mirror or any obstruction, such as the carbons and their holders, can possibly be focused at the screen, the film plane being the only plane thus focused. It is governed by the same principle which prevents a broken condenser showing in a motion picture, whereas it shows plainly in a stereo picture. See page 443, first volume.

To this we might add that the reason some makes of reflector type lamp use only one side of the mirror for slide projection is because the long focal length stereo projection lens has such great depth of focus that if the center of the mirror were used it would include in the screen image an out-of-focus image of the carbons and their holders.

SIZE OF MIRROR.—Referring to Fig. 309A it will be observed that the diameter of the mirror or reflector does not necessarily indicate the angle, or amount of light "picked up" and reflected back. A small diameter mirror may actually pick up and utilize as much or more light than the larger one, provided the light source be close enough to its surface, and the curvature of the mirror be such as will focus all the reflected light at its correct point in the spot at the projector aperture. However, there are, of course, limitations beyond which it is impossible to go, because of the high temperature of an electric arc light source.

DANGER FROM OPENING NON-EXISTENT.—In the reflector are lamp using spherical mirror, the opening in the front of the lamphouse where the condenser ordinarily is, is entirely open and free. Some officials have feared that this would add to the fire hazard. In our opinion they are in error, insofar as has to do with the escape of sparks from the carbon, because even the most light incandescent particles of carbon could hardly, by any conceivable chance, escape through the opening and reach the film. Moreover any particle of incandescent matter light enough to float in air, would not have sufficient heat to set fire to film, especially since it would not come into direct contact with anything but the photographic emulsion, which is not especially inflammable; also it is an important fact that, in the very nature of things, there is always a strong current of air entering through the opening at the front of the lamphouse, which passes up through the vent flue.

HEAT OF THE SPOT.—That there is added heat at the spot by reason of the absence of a condenser, or by reason of the reduction of the thickness of glass brought about by the substitution of one thin condenser lens for two thick ones, is true. It is a fact that the reflector arc lamp operating at twenty-five amperes produces fully as hot a spot as does the high amperage ordinary arc. It is even claimed by some that it has higher temperature than any light source yet used for motion picture projection.

Well, suppose the claim is true. What of it? The reflector arc lamp has been in use in this country in considerable numbers during the past two years. They have been in very general use in European countries during that period of time, and in considerable use for an even longer period. In fact this type of lamp has virtually superceded all other light sources for motion picture projection in some countries of Europe, and up to date we have heard of no greater percentage of fires, either in this country, Canada or elsewhere, since they have come into use.

As a matter of fact, with any light source acceptable for the projection of motion pictures under modern practice, the time required to fire the film, once it has become stationary over the projector aperture, and thus exposed to the light, is so very short that any added heat the reflector arc might produce would merely shorten it by a small fraction of a second. That this is exactly the real condition, every one familiar with motion picture projection knows. We submit that the addition or subtraction of the fraction of a second could not and would not make any real practical difference in the item of fire hazard, insofar as has to do with actual practice.

Modern professional motion picture projectors are so constructed that if they be kept in order, and if the projectionist be and remain beside them when they are working, there is little if any danger of an aperture fire getting away from the aperture. The danger of the fire getting into a magazine comes largely through the projectionist being elsewhere than in his rightful place beside the projector when, through some mishap the film, or some particle torn from it, becomes stationary over the aperture.

WE MAKE THE UNQUALIFIED ASSERTION THAT THE TIME FOR FIRING THE FILM WHEN USING A LIGHT SOURCE GIVING THE MINIMUM AMOUNT OF HEAT AT THE SPOT IS, IN PRACTICE, SO VERY SHORT THAT ANY ADDED HEAT BELOW THE TEMPERATURE WHICH WILL WARP THE PROJECTOR MECHANISM FRAME, OR MAKE THE METAL ITSELF DANGEROUSLY HOT, DOES NOT AND CANNOT POSSIBLY ADD APPRECIABLY TO THE ELEMENT OF FIRE HAZARD.

ABUSE OF MIRROR.—It is necessary to the successful operation of reflecting arc lamps that (A) the rated amperage capacity of the equipment be not exceeded. (B) That the light source be not less than the minimum permissible distance from the mirror. If the lamp be worked above its rated capacity and the mirror does not stand up under such abuse, the projectionist and NOT the equipment is to blame. If you work the lamp with less than the minimum permissible distance from light source to mirror, you are subjecting it, the mirror, to a degree of heat it was not designed to withstand; also you are abusing the optics of the equipment, and not getting the results you should. While this latter is true of both condenser and non-condenser types of lamp, it is especially necessary that the light source be kept at exactly the correct distance when using the condenser type, because the mirror is presumed to project a parallel beam forward to the condenser, and will not do so unless the distance crater to mirror is exactly right.

CAUTION.—It is very difficult to construct a mirror backing which will withstand the high degree of heat to which the mirror must be subjected when used with an electric arc located a matter of only about three inches from its face. IT IS THEREFORE VERY IMPORTANT THAT THE TEMPERATURE INSIDE THE LAMPHOUSE BE KEPT AS LOW AS IS POSSIBLE. The projectionists who would avoid trouble when using reflector type lamps will see to it that the lamphouse ventilation is and remains as open and free as possible without causing unsteadiness of the arc.

However, care must be exercized that there be not too strong a draft through the lamphouse, since they will cause an unstable arc, partly because of the horizontal position of the electrodes. The gasses which support the arc tend to rise in any event, and if they be assisted by a strong draft the result is easily understood. Another contributing factor in this matter is the relatively low amperage used. However, use all the ventilation possible, and it is not altogether unlikely that something might be done to shield the arc by the use of a small, carefully placed asbestos baffle plate.

NOTE.—It probably is advisable to inform you that while for the first year or two after the introduction of the reflector arc lamp into this country, much difficulty was experienced in the matter of mirror backing, which would chip and peel off in spots, carrying the silver reflection surface with it; also in some cases the backing disintegrated as a whole. This trouble has been very largely overcome.

The Bausch and Lomb Optical Company were the first to find a really satisfactory backing, which consisted of either fireclay or a composition closely resembling it. It was sprayed on in semi-liquid form, over the silver coating on the mirror back. Two or more coats were applied, and each separate coat was baked at a temperature considerably in excess of the temperature the mirror would be called upon to withstand in ordinary practice.

Since the introduction of this backing, trouble with chipping, peeling and disintegration has gradually been reduced until now, from all reports, it is a negligible quantity.

WARNING.—It is not unlikely that, if the practice has not already appeared, mirrors for reflector arc lamps will be placed on the market by irresponsible parties. In purchasing goods of this kind it is extremely unwise to consider anything not bearing the trade mark of a responsible, thoroughly reliable business institution—an institution which will make a reasonable guarantee and back it up. If you do buy goods of this kind which do not bear such a trade mark, you are inviting trouble, and deserve no sympathy if you get it.

CRATER POSITION.—The positive carbon should be centered exactly on the optical axis. This position may be checked by advancing the positive carbon and making sure that it is exactly central in the central mirror opening.

There are two types of crater in use, both illustrated in

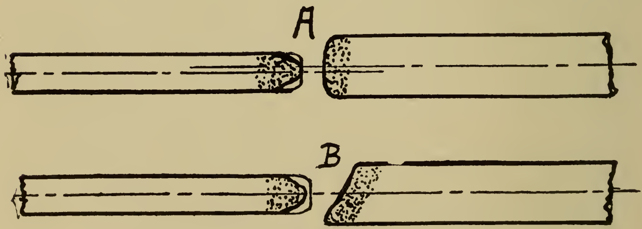


Figure 315A

Fig. 315A, in which the blunt nose crater is illustrated at A and the angle crater is shown at B.

These two types of crater of course result directly from the setting of the negative carbon tip with relation to the positive carbon tip. The one shown at B is not a good crater. The one above at A is an ideal crater, and one which, if properly located as to distance from the mirror surface, will deliver maximum results.

The crater shown at B, Fig. 315A, bevels backward away from the mirror, for the reason that the negative tip is a trifle too high with relation to the positive. The remedy is to lower it gradually, until the point is found where the crater burns as nearly as possible square, as shown at A, Fig. 315A. It will, of course, not be found possible to force the crater to burn absolutely square, as shown at A, because of the action of the hot gasses which rise and tend to burn off the upper edge of the crater, but by careful work a very close approximation to the condition shown at A, Fig. 315A, may be had.

It is of course understood that the carbons must be in exact line with each other sidewise, but that, we believe, is taken care of in the lamp itself when it is made.

IMPORTANT CAUTION. — NEVER PERMIT THE NEGATIVE CARBON TO BE SO LOW THAT THE CRATER BEVELS DOWNWARD, opposite to the condition shown in B, Fig. 315A.

METAL COATED CARBONS.—Avoid them when using reflector arc lamps, as they are likely to pit the mirror surface, and any injury of that sort will reduce its reflective power in exact proportion to the area of the surface thus ruined.

CARBON SIZES.—See page 400½.

IMPORTANT—WARNING.—With high intensity and ordinary arc lamps it has been possible to get fairly good results, though at the expense of great loss in efficiency, by using carbons far from the correct size (diameter) for the amperage used.

THIS CANNOT BE DONE WITH THE REFLECTOR TYPE LAMP, WHICH IS VERY SENSITIVE TO CORRECT CARBON DIAMETERS FOR ANY GIVEN AMPERAGE. UNLESS YOU KEEP YOUR CARBON DIAMETERS VERY CLOSE INDEED TO THEIR FULL AMPERAGE RATING YOU MAY EXPECT HEAVY FALLING OFF IN EFFICIENCY—IN SCREEN ILLUMINATION.

CLEANING MIRRORS—IMPORTANT.—Surely no argument is necessary to convince you that a mirror surface fogged with dirt cannot possibly be expected to give maximum results in reflection. The surface of a mirror must be perfectly clean in order to develop its full power in light reflection, therefore it follows that the efficiency of the reflector type arc lamp is directly in proportion to the percentage of the total light its reflector receives and the efficiency of its surface as a reflector.

A mirror coated with carbon ash, or dirt of any sort whatsoever cannot be expected to operate well and if the coating be heavy enough to fog the surface as a whole, the performance will be very poor indeed.

Never assume that a mirror is clean, merely because it looks clean to the eye. Make it your invariable practice to clean all mirrors carefully, but thoroughly, before you start the days run, or when you come on duty if you have a second shift. It is very difficult to lay down any rule as to how often mirror surfaces ought to be cleaned, but certainly they should not work more than five hours without attention. The surfaces are exposed to the gasses from the arc, and certainly the polished glass surface will fog to some extent in that time, especially if maximum amperage is used.

USE ONLY VERY SOFT, CLEAN CLOTH OR SOFT TOILET PAPER TO CLEAN MIRRORS. Breathing on the surface of a mirror while it is cold, wiping and polishing while still damp is both simple and effective. However, wood alcohol in its full strength is not expensive and is effective, though we believe a solution of from equal parts of wood alcohol and water, or three parts of wood alcohol to one of water is better than full strength because it does not dry too rapidly, hence gives more time for polishing.

CAUTION—THE SURFACE OF THE MIRROR SHOULD BE CLEANED EVERY DAY. If you neglect this plain, obvious duty and permit the surface to become heavily coated with ash and dirt, BE CAREFUL TO CHANGE YOUR CLOTH OR PAPER OFTEN WHEN CLEANING THE SURFACE. If you do not you will soon find the surface of the mirror to be dulled, though you can probably see no actual scratches. The ash is a very fine substance and will, under the polishing process, not make visible scratches, but will make invisible ones just the same, and thus GRADUALLY RUIN THE MIRROR SURFACE.

TWO TYPES OF REFLECTOR ARC LAMP.—There are two distinct types of reflector arc lamp. It is not within our province to give advice as to which, if either of them, may be superior to the other. Our purpose is to tell you exactly what they are, how they operate, and to describe the various makes to you, leaving you to pass judgment upon their individual merits.

One type functions without any condenser at all, depending entirely upon a mirror to reflect the light, and at the same

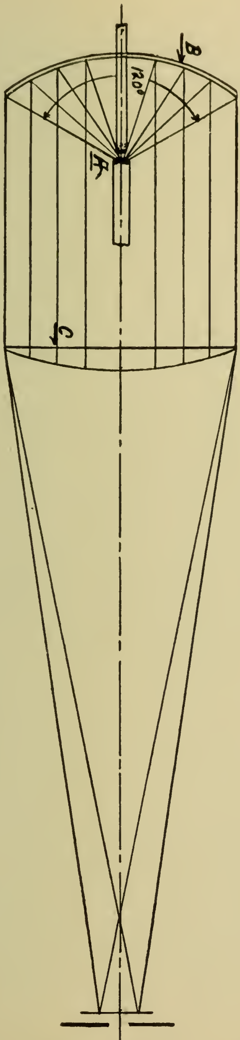


Figure 315B

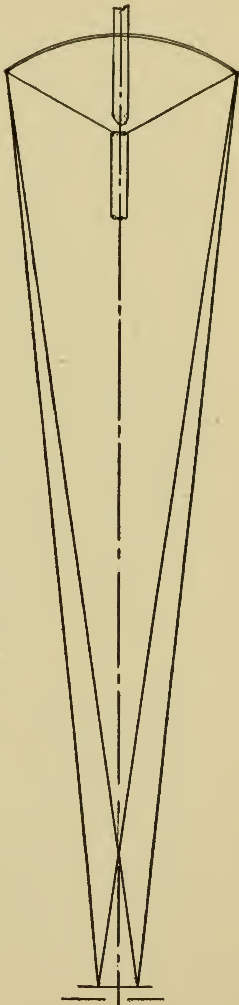


Figure 315C

time converge it so as to form the "spot" at the aperture of the projector mechanism.

The other type uses a mirror which reflects the light back, in the form of a parallel beam, the full diameter of the reflector surface, to a single plano-convex condenser lens of the same effective diameter as the mirror. This lens converges the beam to form the spot at the projector mechanism aperture. The system is illustrated in Fig. 315B in which A is the light source, located approximately three inches from the surface of the mirror. The mirror "picks up" an angle of light of approximately 120 degrees, which, as has been said, is all the light which it is possible to utilize efficiently in such a system, and probably very close to ninety per cent of the total light given off by the light source. It will therefore be seen that the system employed is very efficient in light collection.

The condenser, as is seen, receives the parallel beam on its plano surface. The lens is quite thin and the curvature slight, hence both reflection and absorption is reduced to the minimum. If the lens be kept clean the combined loss of reflection and absorption should not exceed ten per cent.

The condenser forms an excellent, sharply defined spot, and the resultant screen illumination is very evenly distributed. In Fig. 315B, B is of course the mirror and C the condenser.

There is considerable argument between the manufacturers of the two types of lamp as regards the light losses due to size of spot, but since the parrabolic and elliptical mirror has displaced the spherical mirror in reflector of lamps, the performance of the two with relation to the smallness and sharpness of spot is essentially the same. However I shall give you the setup of one non-condenser reflector arc lamp, made by a large projector manufacturing company, and you may size up its possibilities for yourselves, always remembering that I have not shown the aberration.

Figure 315C is the non-condenser line-up. In this instance the mirror itself reflects and converges the light beam to the spot at the aperture. The distance mirror to aperture is long, which is necessary in this type of lamp. It is what might be called the "straight reflector arc lamp, and has shown some astonishing results in screen illumination.

POWERLITE REFLECTOR ARC LAMP. GENERAL DESCRIPTION.—This equipment consists essentially, exclusive of the motor and relay control, of three principal units, viz: a positive carbon holder, a negative carbon holder, and a

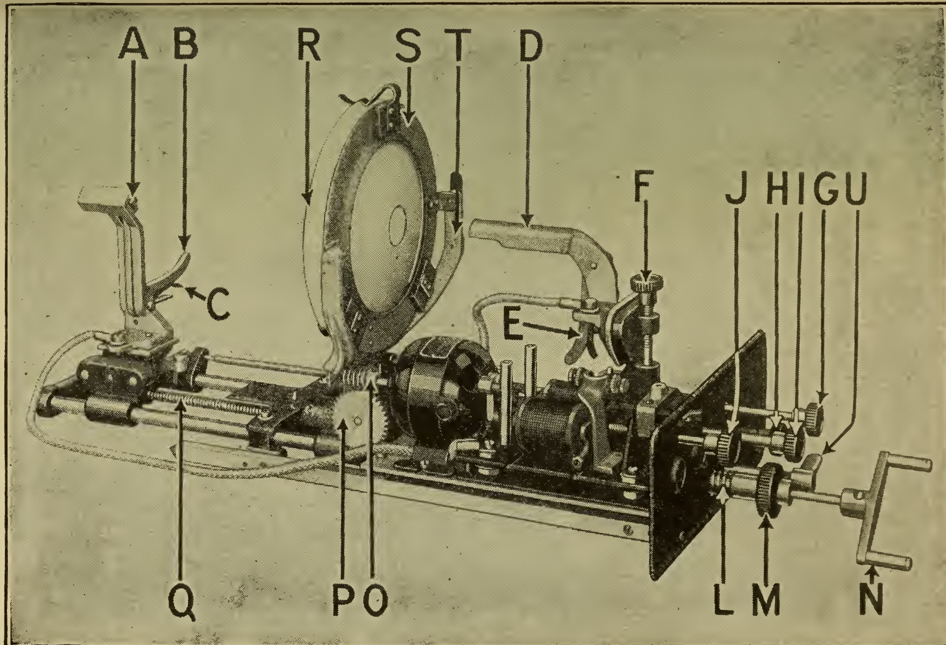


Figure 315D

A—Positive carbon clamp. B—Positive carbon release lever. C—Positive carbon clamp spring. D—Negative carbon clamp. E—Negative carbon clamp release lever. F—Vertical adjustment for negative carbon. G—Lateral adjustment for positive carbon. H—Knob for vertical adjustment of reflector. I—Knob for lateral adjustment of reflector. J—Knob for relay adjustment. K—Relay control mechanism. L—Screw for adjusting positive crater. M—Knob for screw L. N—Hand feed crank. O—Motor worm. P—Worm gear. Q—Carbon feed screw. R—Reflector. S—Reflector holder. T—Support for reflector holder.

mirror, with its supporting base, which may be made to move backward or forward on two parallel rods. The positive and negative carbon holders are connected by means of a long feed screw carrying on its circumference a left hand thread at one end, and a right hand thread at its other end, this screw terminating at its rear end in a double-handled crank, N, Fig. 315D. By rotating this screw the negative and positive carbons are simultaneously moved toward each other, or away from each other, according to the direction of rotation. While this is true, still by means of knob M, Fig. 315D, which is attached to screw L, it is possible to move the positive and negative, as a whole, in either direction for a distance of one inch. This is to facilitate placing of the crater the correct distance from the mirror, and to enable the projectionist to compensate for the possible more rapid consumption of one carbon than the other.

The positive carbon is held in place by means of lever B, Fig. 315D, which is held under tension by means of a flat spring attached to its under surface, C, Fig. 315D. The negative carbon is clamped into place by means of a similar lever, E, Fig. 315D, also held under the tension of a coil spring.

The carbon clamps are so designed that they will accommodate any diameter carbon suitable for the range of amperage the lamp is designed for. The positive carbon holder has no vertical adjustment, but is in permanently fixed position, as to height, so that the positive carbon is always centered on the axis of the optical train. A sidewise adjustment is, however, provided, which is controlled by knob G, Fig. 315D.

The negative carbon holder, on the other hand, has no lateral (sidewise) adjustment, being in fixed position, so that it exactly centers the negative carbon on the axis of the optical train sidewise. It may, however, be raised or lowered by means of knob F, Fig. 315D. The up and down movement of the negative and the sidewise movement of the positive provide means for accurately adjusting the carbon tips with relation to each other, and no up and down movement of the lamp, as a whole, is necessary.

Power is transmitted from the arc control motor to the carbon feed screw Q, Fig. 315D, by means of a train of worms and gears, the first one of which, O, Fig. 315D is attached directly to the motor shaft. It meshes with gear P, Fig. 315D, which, through an intermediate shaft operates a second, similar set of two gears. In the gear train is a friction clutch which permits of the arc being "struck," or of its being fed by hand, without disengaging the feed screw from the driving mechanism.

The mirror is supported by three spring clips, so designed that the mirror may readily be removed for cleaning. These clips are electrically insulated from the mirror support disc. The mirror support disc is mounted on cast trunions, which are, in turn, pivoted on their base. This permits the mirror to be swung from side to side, and up or down, on both its vertical and horizontal axis, which movement is controlled by knobs I and H, Fig. 315D, at the rear of the lamphouse.

The entire lamp, together with its relay control apparatus, is so mounted that it may be either partially withdrawn from the lamphouse at its rear, or merely by releasing a spring catch and removing a section of the rear lamphouse wall the entire lamp assemblage may be entirely withdrawn from the lamphouse, Fig. 315H.

POWERLITE RELAY CONTROL.—The Powerlite relay is set to operate at arc voltage (50 to 55 volts) before leaving the factory, and has been designed to give very close carbon feed control on any current strength within the capacity limitations of the carbons used. The rate of carbon feed is controlled by but one adjustment, knob J., Figure 315E, which regulates the tension of the relay magnet counterbalance spring D, Figure 315-E. One end of this spring is attached to armature B, and the other end to the adjusting shaft J. There is but one moving part in the relay control, viz. the armature B. Arc voltage is impressed on the heavy duty control coils which magnetize their iron cores, the strength of magnetization being in proportion to the current flow. The cores of course attract armature B. The tension exerted by tension spring D counteracts the pull of the magnetized iron cores and inasmuch as this tension can be very accurately controlled, the relay will operate to feed the carbons on a rise of approximately one volt across the burning arc. Turning knob J clockwise acts to decrease, while turning it counterclockwise acts to increase the length of the arc and hence the arc voltage. If the tension spring D is adjusted until the arc is being fed at regular intervals when the arc is at proper length, then the proper arc gap will be constantly maintained. Once this adjustment is properly made for the current used, no further adjustment is necessary.

A toggle switch shown at S, Figure 315E, is inserted in the relay circuit for disconnecting both the control and motor circuit, without in any way interfering with the supply of current to the lamp itself. To prevent the motor from racing this relay switch should be set in the "off" position before striking the arc and should always be in the "off" position when using alternating current at the arc during an emergency. After the arc is struck on direct current taken either from the line or motor generator set, the switch should be set in the "on" position. At the base of the lever of the relay toggle switch will be found a small white spot. This spot when visible indicates that the switch lever is in the "on" or closed position; when invisible it is in the "off" or open position. The relay itself will require no attention, once adjusting knob J, Figure 315-E, is properly set. **The adjustment of the contact points is correctly made at the factory and should not be disturbed unless the contact screws have become loosened due to jarring in transit.** The contacts under these conditions should be set so that when they are closed, armature B, Figure 315-E, is in a vertical position, and the faces meet squarely. The gap between the movable armature B, Figure 315E, and the fixed contact A, Figure 315E, should be approximately ten one-thousandths of an inch. The length of the gap can be varied by moving the knurled screw carrying the small fibre back stop C, Figure 315E, against which the contact arm of armature B, Figure 315E, rests when it is in the forward position, and the contacts are open. The contact points are made of platinum, and an especially designed unit connected across these points entirely eliminates sparking, thus rendering the platinum points practically indestructible. Should it at any time be necessary to remove the relay and motor as a unit, first loosen the two screws G, Figure 315E, holding the toggle switch in its support, and push the switch backward until its lever clears the slot in the lower back plate of the lamp. This will expose the rear bed plate screw. Disconnect the feed wires from binding posts E plus and F minus, Figure 315-E, remove the screw in the rear and the two screws in front of the bed plate on which the relay and motor are mounted. The entire motor and control assembly may then be lifted from the lamp. The motor alone can be readily removed without disturbing the relay, by disconnecting the two motor leads at the front of the relay base and removing the two screws by which the motor is fastened to the bed plate.

THE LAMPHOUSE.—The Powerlite lamphouse has ample ventilation, is of ample size and well made from substantial materials. In its door is an observation window of goodly size. The door opens by pushing it upward, whereupon it slips

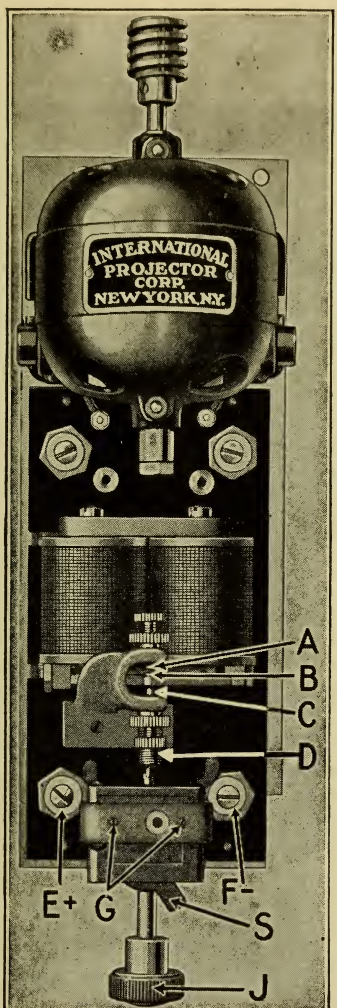


Figure 315E
Powerlite Control Relay

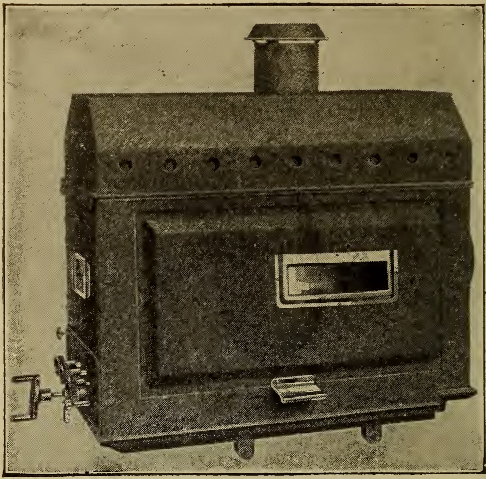


Figure 315F
Powerlite unit as a whole

inward, under lamphouse roof, where it will remain until pulled down. It is a unique and excellent arrangement.

As has been said, the rear of the lamphouse is so arranged that its back wall may instantly be removed, and the entire lamp assembly be removed, if desired, or the lamp may be pulled part way out. The lamphouse is supplied either with or without stereopticon attachment. The attachment may be applied to your lamphouse at any time, if you wish to add it to the equipment. The attachment consists of a sheet metal plate which forms the front wall of the lamphouse. Attached to this plate is a slide carrying the opening and cone for motion picture projection, and the stereopticon condenser holder, a condenser being necessary for slide projection. There is an arrangement for shifting the mirror forward for stereopticon projection, explanation concerning which will be given later.

INSTRUCTIONS FOR OPERATION. CONNECTING.—When you remove the cover of the relay, you will see binding posts E+, F-, Fig. 315E. When facing the back end of the lamp pass the positive wire through the left hand bushing and connect it to terminal E+, Fig. 315E, the left hand terminal. The negative wire must be passed through the other, right hand, bushing and connected to terminal F-, the right hand terminal. That is all there is to it, all other connections having been made at the factory.

THE CARBONS.—Having selected the correct size carbons, as per accompanying advice, you have but to press down on levers B and E and slip them into place. Bringing the ends of the carbon against the carbon stop studs prevents carbon slipping in holders and also provides for correct position of crater, the positive going in clamp A, Fig. 315D of course. Releasing the levers automatically clamps the carbons into place.

The positive carbon clamp A, Fig. 315D is V shaped and is so mounted that when the carbon is clamped therein, its center is on the optical axis of the lens system, insofar as has to do with its up and down position, hence, as has been said, there

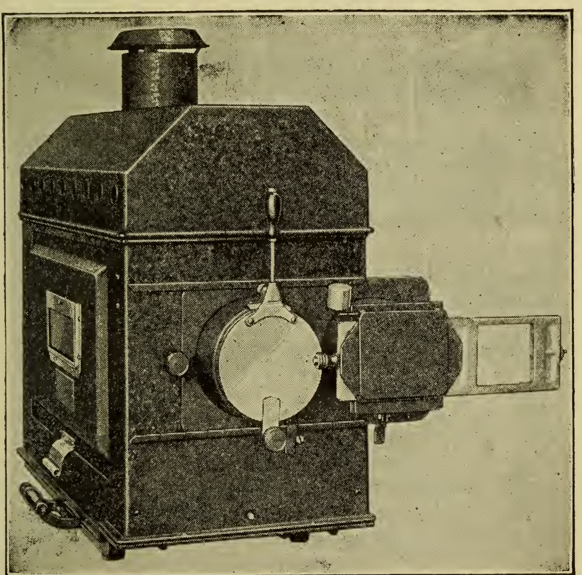


Figure 315G
Showing stereopticon attachment

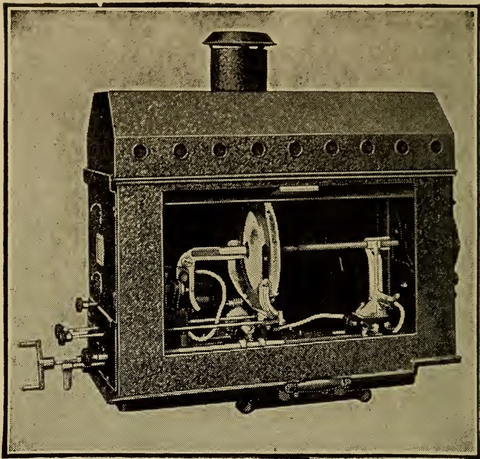


Figure 315H

Lamphouse, showing lamp which may be withdrawn

is no up and down adjustment provided for the positive carbon clamp. However, because of the fact that carbons of different diameter may be and are used, a side-wise adjustment is provided. This movement is accomplished by means of knob G, Fig. 315D.

The negative carbon clamp, on the other hand, has no side-wise adjustment, but knob F, Fig. 315D, provides a vertical movement. You have, therefore, only to install the carbons in their respective clamps, and so adjust their tips, by means of knobs G and F, Fig. 315D, that the center of the negative tip is approximately 1/16 of an inch below the center of the positive carbon tip, to know that you are correct, insofar as has to do with the alignment of the carbons.

CRATER DISTANCE.—In installing the positive carbon it is essential that its tip be exactly the correct distance from the mirror. This correct distance is 4½″ from the center face of the mirror in the case where the spherical mirror is used and 4″ in the case where the new "Elflex" or elliptical mirror is used. Practically all Powerlite lamps are now equipped with the "Elflex" reflector and the carbon stop studs now used on the carbon holders are so located as to bring the positive crater in its correct location with relation to the reflector; all that is necessary is to insert a full 8" trim, bringing the ends of the carbons against the stop studs. No guage of any kind is necessary.

NOTE.—To distinguish the elliptical mirror from the spherical mirror look for the name "Elflex" near the Bausch & Lomb trade mark.

At the rear of the lamphouse, mounted on the shaft of handle N, is knob M and screw L, Fig. 315D, all held in place on screw shaft Q by a collar. By turning knob M you may move the positive and negative carbons, as a whole, backward or forward the distance of one inch, or any part thereof.

IMPORTANT.—When placing the positive carbon tip in position 4½ or 4" from the mirror, as described, this adjustment (knob M) should be in its central position, so that if it be necessary to alter the distance of the crater from the mirror while projection is in progress, it may be moved either way by means of knob M.

LUBRICATION.—A few drops of light machine oil should occasionally be applied to the slide rods on which the positive and negative assemblies move back and forth; also to feed screen Q, Fig. 315D. The bearing for the intermediate drive should have ONE OR TWO drops of good oil every day. Oil holes are provided. Also apply a few drops of good oil to the arc control gears daily. DO NOT OVER-OIL. It does no good and makes a nasty mess.

CENTERING THE SPOT.—The spot at the aperture is centered by tipping the mirror up, down or sidewise, by means of its control knobs, I and H, Fig. 315D. The correct distance of the mirror center from the spot is 22 inches for the spherical mirror and 24 inches for the elliptical mirror.

STEREOPTICON ATTACHMENT.—To use the stereopticon attachment, pull the slide which forms a part of the front lamphouse wall toward you until it strikes the stop. Move the mirror holder assembly forward approximately 1⅜ inches by means of knob and a shift lever, Fig. 315D. The shift lever must be turned slightly to the left (upward) and the rod to which the lever is attached pushed forward as far as it will go, and the shift lever returned to its normal, locking position, pointing downward. Having done these things, the mirror is in correct stereopticon position and it only remains to shove the whole lamphouse over into position in order to begin stereopticon projection.

After stereopticon projection is finished, the lamphouse must be pulled back, and the mirror and slide at front of lamphouse returned to their original positions, whereupon motion picture projection may be resumed.

The reason for this procedure in stereopticon projection is to parallel the light beam sent forward to the slide by the mirror. This must be done, else the shadow of the carbons and their holders will appear on the screen. In order to avoid this the condenser employed in stereopticon projection is not located in the center of the light beam, but to one side, as you will observe, and the carbon shadow is thus avoided. In front of the condenser you will see a wedge-shape glass prism. This is to bend the light beam back into central position, on the optical axis of the projection lens.

CARBONS — MANUFACTURER'S RECOMMENDATIONS. Do not expect to get results on this or any other type of low intensity arc lamp if carbons are used on amperages for which they are not designed. Carbons for low intensity reflector lamps are made within very close limits for the very small variation in amperages used in connection with reflector lamps. The following table should be strictly adhered to:

10 to 15 amperes—	positive diameter 9 mm.	length	8″
	negative diameter 6.4 mm.	”	8″
16 to 20 amperes—	positive diameter 10 mm.	”	8″
	negative diameter 7 mm.	”	8″
21 to 25 amperes—	positive diameter 12 mm.	”	8″
	negative diameter 8 mm.	”	8″
26 to 30 amperes—	positive diameter 13 mm.	”	8″
	negative diameter 9 mm.	”	8″
31 to 35 amperes—	positive diameter 14 mm.	”	8″
	negative diameter 10 mm.	”	8″

The above applies to both National and Bio carbons, except that where Bio "SA" carbons are used one size smaller may be substituted for the sizes above given. It will be noted that for a very slight increase or decrease in amperage the carbon diameters MUST BE CHANGED, and unless such changes are strictly followed the best results will positively not be obtained.

PEERLESS REFLECTOR ARC LAMP EQUIPMENT.—The Peerless Reflector Arc Lamp utilizes the Reflector-Condenser optical system, its condenser being eight inches in diameter, with a free opening of slightly more than 7⅝ in. after being mounted.

The Peerless Reflector is of the parabolic type, its diameter being 7⅝ in., the same as the free opening of the condenser. The reason for this is that being a parabolic reflector the light rays reflected from it are all parallel rays when the light source is at the exact focal point of the reflector, or in other words it reflects a cylinder of light the exact diameter of the reflector and the free opening of the condenser.

The manufacturers claim that a parabolic reflector can only be operated at its highest efficiency when the light source is carried at its exact focal point, and when this is done the reflected light rays are theoretically parallel; hence, the reflector should be the same diameter as the free opening of the condenser and likewise the cylinder of light reflected by it.

It is also claimed that as the light rays enter the condensing lens in a parallel stream, the angle of light convergence and divergence is much flatter or less rapid than it would be if the light entered the lens from a converging angle, and by this flattening of the light angle between the condenser, aperture and objective lens of the mechanism, a greater amount of light is passed through the projector objective lens.

Also that by the use of a proper focal length condenser (which controls the diameter of the cooling plate spot), the lamphouse may be used still farther away from the mechanism and again obtain a further reduction of light convergence and divergence and a correspondingly greater amount of illumination is again passed through the projection lens.

Each complete Peerless Reflector Arc Lamp equipment, as packed for shipment, is contained in two separate shipping cases, the larger of which contains the lamphouse, with the lamp assembled therein, and the converging lens, the reflector, light cone and stereopticon attachment.

WARNING.—In packing the apparatus it is essential that you use great care in order to avoid possible injury to it. It is astonishing how careless some men are in this respect. Don't YOU be one of them.

The apparatus in the larger case is held in place entirely by means of wooden cleats designed for the purpose. No excelsior or other packing materials is used. REMOVE THE NAILS HOLDING THESE CLEATS BY PULLING THEM FROM

THE OUTSIDE SURFACE OF THE PACKING CASE. Don't attempt to knock the holding cleats out with a hammer, or to pry them out with a bar. Make haste slowly in this matter, and remove the nails first.

The arc controller is in the smaller case. It is wrapped in paper and bedded in excelsior. Remove the wrapping and clean thoroughly before installing.

INSTRUCTIONS FOR INSTALLATION.—The Peerless Reflector Arc Lamp equipment is intended for use on any make of standard professional motion picture projector, which in this country and Canada means the Powers, Simplex, Motiograph DeLuxe and Special, and the Baird. Except in the case of the Simplex, the equipment is fitted to the projector by means of an "adapter," which carries the Peerless lamphouse and fits on the regular lamphouse side rods of the various projectors, it being necessary to specify the make of projector when ordering Peerless Reflector Arc Equipment, so that the right adapter may be sent.

In the case of the Simplex projector the Peerless lamphouse base casting is machined exactly the same as is the regular Simplex lamphouse base, including the "Type S," so that no adapter is required.

INSTALLING PEERLESS LAMPHOUSE ON SIMPLEX PROJECTOR.—To do this it is only necessary to remove the Simplex lamphouse by removing the two wing nuts on the under side of the table casting, lift the lamphouse off, lift the Peerless lamphouse into place, put on the aforesaid wing nuts and tighten them up.

It is recommended by the manufacturer that after installing the lamphouse you do NOT strike the arc, or do anything else until the arc controller is installed and connected up ready for business.

To install the Peerless on projectors other than the Simplex, first bolt the "adapter" to the base of the lamphouse, tightening the four screws securely. Next remove the regular projector lamphouse from the rods upon which it slides sidewise, and install the Peerless thereon by means of the holes provided in the adapter.

ATTACHING ARC CONTROLLER.—Having the lamphouse properly installed, proceed to install the controller, as follows: In the shipping case with the controller you will find two short steel rods. One end of one of these rods shows at AC 8, Fig. 315-I. At the bottom of the left side of the lamphouse you will find two holes in the lamphouse wall, just inside of each of which is a cast lug into which these rods fit. Insert the rods into the lugs and tighten the set screw in the lug to hold them in place. Next place the arc controller on the rods, at the same time entering the drive shaft on the rear of the controller gear housing into the universal feed tube at the bottom of the gear housing on the back end of the main carbon feed screw. Be sure that the pin on the shaft enters the slot in the tube properly. Also take particular care that in adjusting the Arc Control in toward the lamphouse on its support rods, that you do not get it so close to the lamphouse as to cramp the universals on each end of the telescoping feed shaft. When this is completed, tighten the set screws in the lugs down tight, in order to hold the controller in place, which completes the job, in so far as the mechanical installation of the controller be concerned.

CONTROLLER ELECTRICAL CONNECTIONS. (See page 608).—Next, remove the controller relay assembly cover and make sure the fuses which protect its electric circuit have not worked loose. BEAR WELL IN MIND that the Peerless arc controller will NOT operate on alternating current. It is for use ONLY where direct current is used at the arc.

The controller is a voltage governed device, operating under the general principle described and illustrated on page 609. It is actuated by changes in the voltage across the arc, the latter caused by changes in the arc length as the carbons burn away. It MUST be connected in multiple (parallel) with the arc, and the connections MUST be so made that it will receive its current after it has passed through all controlling devices, such as rheostats, rectifiers or motor generators—in other words, at a point between the lamp and the rheostat, motor generator, etc., or between the lamp and any rheostat which may be used in connection with a motor generator.

The most appropriate place to connect the controller circuit is to the binding posts of the projector table switch, on the lamp side thereof—the latter in order that the controller may be electrically "dead" when the projector table switch is open. This last of course presumes that any rheostat there may be will NOT be connected between the table switch and lamp.

Having thus installed and connected the controller, it is, aside from such adjustments as may only be made when it is in operation, ready for use.

INSTALLING LENS AND REFLECTOR.—After carefully

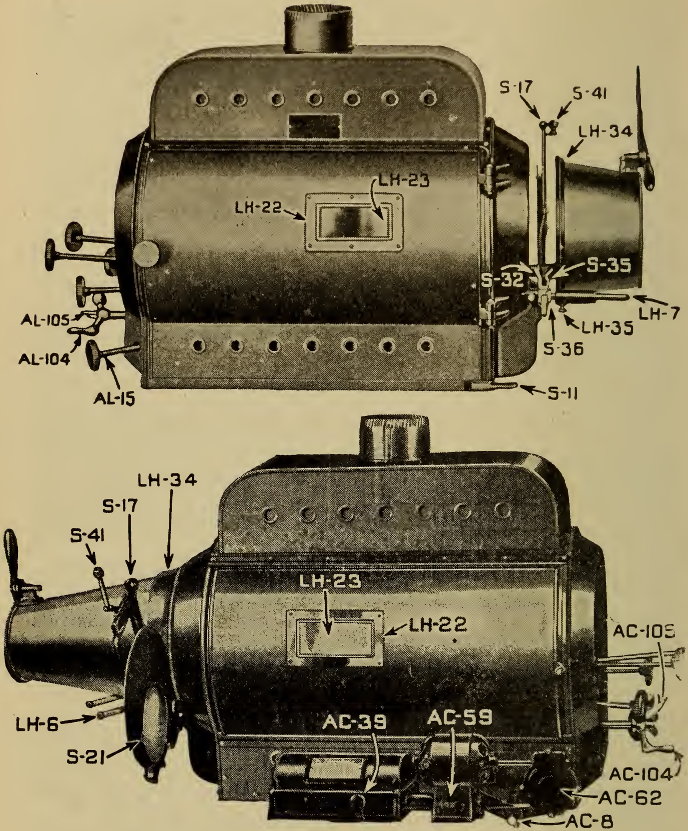


Figure 315-I

cleaning the converging lens, which may be done, unless it is very dirty, by breathing on its cold surface and polishing with a soft, perfectly clean cloth, chamois skin, or with soft tissue paper; also see page 831. The same method may be pursued in cleaning the reflector, or both may be cleaned (manufacturer's recommendation) by washing with a weak solution of household ammonia, procurable at any grocery store. Use about one part of "household" ammonia to three of water.

Afterward wipe dry, polish, using only soft, clean cloth, chamois skin or soft tissue paper.

Having cleaned the converging lens, you will find, on the front side of its holder, or retaining ring, three clips which serve to hold the lens in place. The one at the top is movable. Turn it so that you can slip the lens into place, after which turn the upper clip into position to retain the lens.

It is recommended that the flat side of the lens be placed next the light source.

Next, by exactly the same process, place the reflector in position, having first cleaned its surface, of course.

WARNING.—If the solution of household ammonia be used, be very careful not to permit any of it to reach the back of the mirror, else there is danger that the reflecting surface will be seriously injured.

In placing the reflector in position in its retaining ring, AL 69, Fig. 315J, be sure that the upper latch, or clip is turned into such position that the mirror may be slipped into place without exerting force. Force is unnecessary, and may chip or crack the reflector. When the reflector is in position and properly seated in the ring, you will, of course, turn the upper latch, or clip into position so that it will hold the lens in place.

ADJUSTING THE LAMP.—The saddle, A1-53, Fig. 315J carrying the reflector assembly, is clamped to the lamp bed track rod by means of thumb screw, AL-54, Fig. 315J. It is necessary to place the reflector into proper position, as to its distance from the converging lens, and to do this, first loosen thumb screw AL-54 and move the entire reflector assembly with saddle either forward and backward until the small pointer on the forward boss is brought into alignment with the front pointer that is cast directly into the casting which forms the sub-carriage for the lamp. These pointers are illustrated in figure 315J.

Now by means of adjusting handle No. AL-15 shown in figure 315J, adjust the lamp bed to its center travel position by aligning the rear pointer on the lamp bed lug with the rear pointer also on the rectangular sub-base casting. This will have the effect of bringing the lamp bed to its correct position for trimming and the reflector saddle exactly at the center point of travel between the positive and negative carbon slide saddles designated as No. AL-37 in figure 315J.

This will have the effect of bringing the reflector into correct position, whereupon tighten up thumb screw, AL-54, tightly for this is its permanent location.

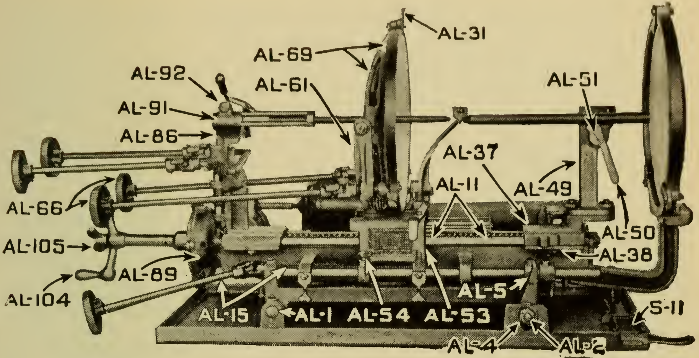
CARBON CLAMPS.—Two sizes of negative carbon holders, or clamps, are supplied with the Peerless equipment. One is for seven and one for eight millimeter diameter carbons. Select the right one suited to your work, and place the shank thereof in the carbon holder support casting, AL-91, Fig. 315J, securing it in place by means of clamp screw, AL-92, Fig. 315J, **in such position that the flat side of its front end will be down.** The lamp bed track with carbon holders, as a whole, are adjustable forward and backward independent of the reflector and it is by this movement that the Arc Crater is adjusted to its correct position in relation to the reflecor.

THE POSITIVE CARBON CLAMPING DEVICE is adjustable to fit any size carbon within range of the amperage for which the lamp is designed. Screw, AL-51, Fig. 315J, is an eccentric, and by turning it clamp AL-50 is either raised or lowered. To turn it you have but to loosen the nut at its rear end. You may then set the clamp in position to grasp any desired diameter of carbon, merely by turning the screw head to the desired position and holding it there while you tighten the nut at its back end. By removing the nut on the rear end of screw AL-51, you may pull the whole thing out, if you wish, and see just how it is made and how it operates.

CAUTION.—When you have adjusted the carbon clamp lever as to height, be sure and tighten nut down solidly, so that the eccentric will not slip when a carbon is clamped into its holder. Better lubricate the screw of the nut with powdered graphite, as it will be subject to some heat.

INSERTING CARBONS.—Having the negative carbon holder in place and properly adjusted, and the positive carbon clamp adjusted for the diameter of carbon you will use, by means of the positive crater position indicator pull bar, AL 123; Figure 315K; bring indicator pointer arm, AL 122, downward; place the positive carbon in position in the holder and clamp it when the end is just even with pointer No. AL-120. The positive carbon crater indicator designates the exact focal point of the reflector, which is the position in which the positive crater should be carried.

After this has been completed, pull outward on bar No. AL-123, Fig. 315K to throw No. A-122 indicator pointer arm out of the path of light reflected by the reflector; bring the tip of the negative carbon to within about three sixteenths of an inch of the positive and, assuming that the lamp has been connected through the proper current controlling device, you


AL-31
AL-69
AL-92
AL-61
AL-51
AL-91
AL-86
AL-37
AL-11
AL-49
AL-66
AL-50
AL-105
AL-38
AL-89
AL-104
AL-5
AL-15
AL-1
AL-54
AL-53
S-11
AL-4
AL-2

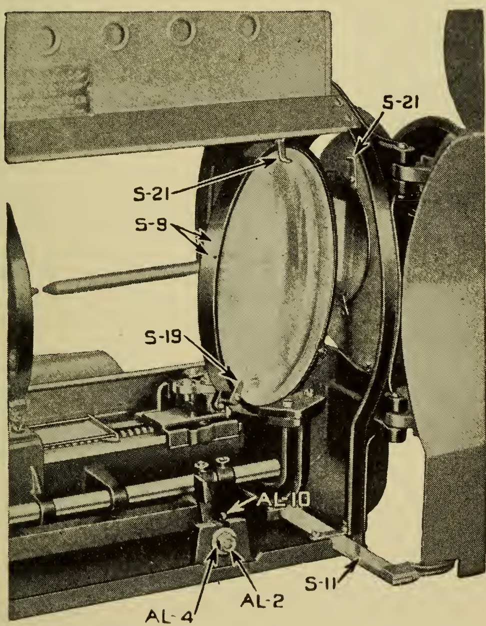

S-21
S-21
S-9
S-19
AL-10
S-11
AL-2
AL-4

Figure 315J

are now ready to adjust the arc controller. Close the table switch and with the arc controller switch OPEN—the controller not operating, strike the arc in the usual way, and permit it to burn until a crater is COMPLETELY formed. It is imperative that the crater be fully formed before proceeding further, because the voltage across the arc when a new trim is burning, is not the same as it will be when the crater has fully formed.

When crater has formed, with wing nut AL-105, Fig. 315J at rear of main carbon feed screw loose, adjust arc to what you think should be about its proper length. Then immediately tighten up the wing nut and close the arc controller switch, putting the controller into operation, and observe what happens.

If the controller motor starts immediately when you close the switch, slowly turn adjusting thumb screw AC-39, Fig. 315-I counter-clockwise (screw it out) until the motor stops. Adjusting thumb screw AC-39, Fig. 315-I, is on the side of the controller.

If, on the other hand, the motor does not start when you close the switch, then turn the adjusting thumb screw clockwise, screwing it in, until the motor starts. You thus have a rough adjustment made for the arc gap you have established by hand. If afterward you think it too long or too short, you may change its length at will by means of the adjusting thumb screw, remembering that turning it the way you would turn a nut on a bolt to tighten it (clockwise) has the effect of shortening the arc gap, while the reverse direction lengthens it.

When you have the arc adjustment made correctly, however, LET IT ALONE, unless there seems to be good reason to think you can improve matters by changing the arc length. Don't be continually monkeying with the adjustments.

OPTICAL ALIGNMENT.—The lens and reflector being in place and clean and the lamp being connected, the controller connected and adjusted and the reflector assembly in correct position, we then proceed to make the necessary optical adjustments, as follows: Strike the arc and close the arc controller switch, putting it into operation. Next, by means of track adjusting handle AL-15, Figs. 315J and L, and the reflector adjusting handle, so adjust the distance from light source to reflector that the light beam completely covers the converging lens, without any appreciable overlap. The light should not show on the ring surrounding the converging lens to exceed 1/32 of an inch all the way around. This is important, so be sure to get it exactly right, remembering that unless you make the adjustments RIGHT (as directed) you have no right to expect maximum results from the lamp.

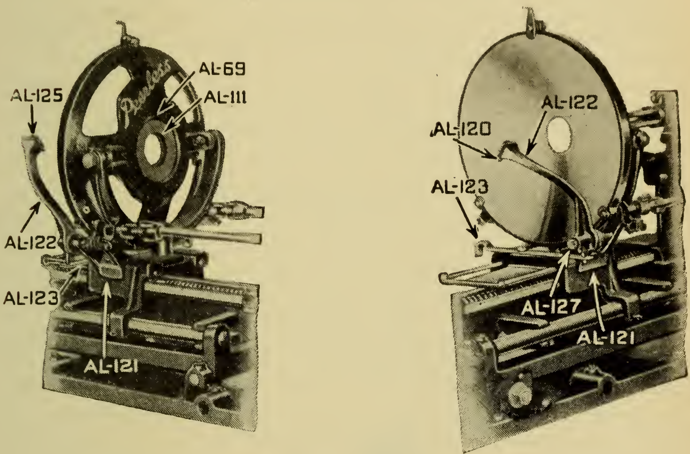


Figure 315K

When you have the adjustment so made that the light beam just covers the entire surface of the condensing lens, and NO MORE, place the lamphouse in position for motion picture projection, and project the light beam to the cooling plate of the projector mechanism. If the spot be either too high or too low, its vertical position may be changed by loosening two hexagon-headed nuts, one of which is shown at AL-4, Fig. 315J, and raising or lowering handle AL-5, which operates an eccentric and raises or lowers the front end of the lamp, according to which way lever AL-5 be moved. When you have the spot centered on the cooling plate vertically, set nuts AL-4 up tight.

Should the spot be off center sidewise, the fault may be corrected by loosening set screw, which is shown as AL-10 Fig. 315J, and shoving the lamp assembly, inside the lamphouse, sidewise until the spot is centered, after which tighten up the set screw again.

Having done these things next prop up the automatic fire shutter of the projector mechanism, move the rotating shutter until the projection lens is "open" and the light beam projected to the screen, whereupon slide the entire lamphouse ahead or back until the position is found where the field of the screen is clear—evenly illuminated. It is essential to efficient operation that the spot be as small as possible. NOTE: When making the last named adjustment, be sure that the light beam from the reflector just covers the entire face of the condensing lens, with no overlapping.

It will be found that eighteen (18) inches from the front surface of the converging lens to the aperture is about right, and that in this position the lamp will over hang the supporting casting considerably.

STEREOPTICON ATTACHMENT INSTRUCTIONS. — When projecting motion pictures the stereopticon lens and slide carrier is out of the way, as per Fig. 315-I, so that the entire surface of the converging lens is open and unobstructed. To project still pictures, pull lever S-11, Figs. 315L, at the front lower end of the lamphouse, outward as far as it will come. This action swings the condensing lens around within the lamphouse, and out of the light beam sent forward by the reflector.

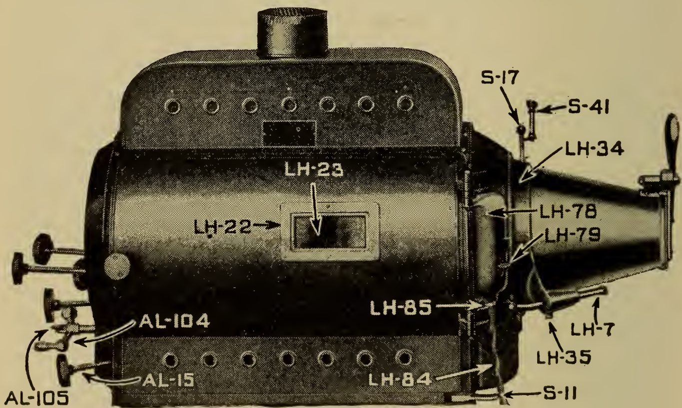


Figure 315L

Next loosen the knurled thumb screw which clamps right hand side of cone support casting LH-34 to support rod LH-7,

Fig. 315L, and move the entire light cone forward on its supporting rods, in order to leave room for operating the slide carrier. Next pull slide carrier handle LH-17 down until it engages securely in latch, and shove the entire lamphouse over into position behind the stereopticon lens.

A reversal of the foregoing will again place the apparatus in condition for motion picture projection. It is of course understood that in the beginning the stereopticon objective lens must be adjusted to center and focus the light upon the screen.

ALIGNING SLIDE CARRIER.—To align the slide carrier, loosen the screw which holds slide carrier in spring catch, and adjust upward or downward until the picture on the screen is perfectly level, after which re-tighten the holding screw. The slide carrier may be moved sidewise by loosening a single screw, which will permit sidewise adjustment of the entire slide carrier assembly. This screw is located directly above the left side support rod for the light cone assembly on the casting which forms the bearing for the entire slide carrier assembly. By loosening this hexagon head screw the entire slide carrier casting may be moved to the right or left for lateral alignment.

The small converging lens located behind the slide carrier is held by two retaining clips, which permit of its easy and quick removal.

LAMPHOUSE PILOT LIGHT.—The bottom of the housing No. LH-78 comes tapped to receive a standard ⅜ in. conduit connector where local requirements necessitate the use of flexible conduit, but is regularly supplied with a porcelain screw bushing for the pilot light leads No. LH-84.

The socket provided is of a key type, the key No. LH-79 extending through the housing casting for convenience in turning on and off the lamp.

LUBRICATION.—It is essential that the arc controller gears, motor and bearings be lubricated, when necessary, with high-grade machine oil—the same you use on your projector mechanism—or at least the grade you OUGHT to use on it. Under ordinary conditions once a week will suffice, provided the oil used be high-grade, just use common sense and oil it the same as you would any light machinery.

MOTIOGRAPH REFLECTOR ARC LAMP

This lamp is of the reflector—condenser type. It employs an optical system especially designed for it, consisting of a parabolic reflector eight and one half (8½) inches in diameter, and an eight (8) inch diameter plano-convex condenser. When the light source (arc crater) is the correct distance from the reflector, it, the reflector, subtends, or "picks up" an angle of 130 degrees of the light.

The reason for employing a reflector half an inch greater

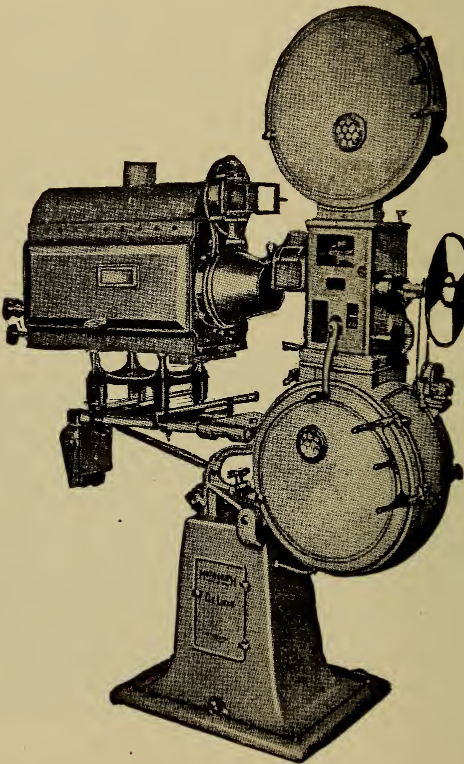


Figure 315M

General View of Motiograph Reflector Arc Lamp Equipment in diameter than the condenser, is so that it may send forward a slightly converging beam, instead of a parallel one. This is accomplished by retarding the light source slightly from the focal point of the reflector.

This action (manufacturer's claim) creates aberrations which operate to offset the spherical aberration which are present in all uncorrected condensers, and thus produced sharper definition in the screen image.

USE WITHOUT CONDENSER.—It is quite possible to use the lamp without a condenser, employing the reflector to reflect and converge the light beam at the projector aperture. The only change necessary to accomplish this is to remove the condenser and so adjust the distance of the light source from the reflector that the light is properly concentrated into a spot on the cooling plate, and the screen illumination even, and at the highest obtainable value. If the lamp is used thus, however, the manufacturer warns us that the efficiency will be lowered, and the spot will not be so sharply defined as when the condenser is used.

INSTRUCTION FOR INSTALLATION AND HANDLING.—The Motiograph Reflector Arm Lamp equipment will reach you packed complete in one shipping case, though the stereopticon attachment (or the cone support if no stereopticon attachment is to be used) the arc control and the attachment base are packed separate from the rest of the equipment, and must be assembled. The reflector, condenser, auxiliary stereo condenser, etc., are also packed separately.

MOTIOGRAPH PROJECTOR.—First remove the old lamphouse, after which place the sliding base attachment on the projector table in exactly the same way the old lamphouse was attached thereto, being certain to replace the two stop collars.

When this is done, place the reflector arc lamphouse on the sliding base attachment you have just installed, in such manner that the four studs on the base enter the four holes in the top of the sliding base attachment. NOTE: Be sure that the four knurled adjusting nuts are on the studs before placing the lamphouse on the sliding base.

ATTACHING ARC CONTROL.—The arc control assembly fits on the two studs projecting from the side of the lamp base. In installing the arc control, be sure the sleeve of the universal joint connection to the feed screw of the lamp engages fully with the shaft protruding from the arc control gear housing, and that you tighten set screw in sleeve so that it is held firmly to the shaft.

ATTACHING STEREOPTICON ATTACHMENT.—First, lay the attachment on a table, flat side down, and with the cone and dowser away from you. Remove the plate upon which the stereopticon slide carrier is mounted, and the retaining ring under it. The auxiliary stereo lens is wedge-shaped. On one side is a concave, or "hollowed-out" curve. The opposite side is convex.

Place the auxiliary lens in the holder so that the convex side is down, with the thick side of the wedge toward your right hand. Next place the retaining ring on top of the lens so that the pin projecting from the ring enters the slot in the holder. Gently work the lens into position so that the bevel side of the retaining ring rests securely on the lens, and replace the plate with the slide carrier so that the openings for inserting slides are upward, or toward the center of the stereopticon attachment.

Next attach the stereopticon attachment to the front of the lamphouse by inserting the bearing stud in the hole over the condenser holder, and tighten down the set screw to hold the bearing stud in place.

When no stereopticon attachment is used, there is a cone and dowser supplied, mounted on a casting which is attached to the lamphouse in the same manner as is the stereopticon attachment.

CONDENSER HOLDER.—To mount the condenser lens, remove the condenser holder from the lamphouse by turning the two wing buttons which are inside the lamphouse and at the bottom of the holder. Turn them so that the wings point directly downward, and turn the one at the top of the holder so that the wing points straight up. The top of the holder may then be tipped back toward the lamp and removed.

Loosen the two thumbscrews which clamp the retaining ring and lay the holder face down on a table, with the retaining ring uppermost. By placing the fingers of each hand on the inside of the retaining ring it may be withdrawn from the holder, whereupon the eight-inch diameter condenser lens may be laid in the holder with its flat side down. When in place in the lamphouse the flat side of the lens is in front—next the projector mechanism.

When the lens is in place, replace the retaining ring and, while pressing it down on the lens, tighten the thumbscrews so that it will be held securely. The holder may then be replaced in the lamphouse and the wing nuts returned to their original position to lock the holder in place.

THE REFLECTOR may be placed in position in its holder by resting it on the two lower spring clips, tipping it backward and raising the upper clip until it permits the reflector to slip into place. The clips are adjustable and should be so set that the mirror will be held firmly.

CLEANING REFLECTOR AND LENS.—See page 831.

ELECTRICAL CONNECTIONS.—Those who supply you the lamp will have complete knowledge as to the proper rheostats and connections to be made for each installation. The positive lead of D C circuits must be connected to the front carbon—the one nearest the condenser—and the negative to the other. The two leads from the arc control are connected to the projector table switch, on its dead side—the side which is electrically dead when the switch is open.

ADJUSTMENTS.—Move the lamphouse backward or forward until the front face of the converging lens (condenser) is approximately thirteen (13) inches from the film when it is in position in the projector. **NOTE:** This distance will vary somewhat with varying focal lengths of the projection lens.

When this has been done, loosen the lock nut on the feed screw handle of the lamp and turn the feed screw handle until the carbon holders of the lamp are separated to the limit of their travel. Insert the smaller diameter carbon in the rear or negative carbon holder, and the larger one in the other (positive) holder. IMPORTANT: So place the carbons that there is exactly the same length of each between the carbon holders.

By means of the adjusting handle immediately to the right of the feed screw handle, adjust the lamp carriage, or bed, so that it is at the central point of its movement backward and forward. Then loosen the thumb screw on the side of the reflector carriage (on the side toward the arc control) and pull the entire reflector assembly toward the rear.

CARBON SIZES.—For twenty to twenty-five amperes the manufacturer recommends a combination of 8 millimeter (See page 400½) negative and a 12 millimeter positive. For fifteen to twenty amperes use 7 mm negative and 10 mm positive. The lamp is fitted with carbon holders for the larger sizes, since

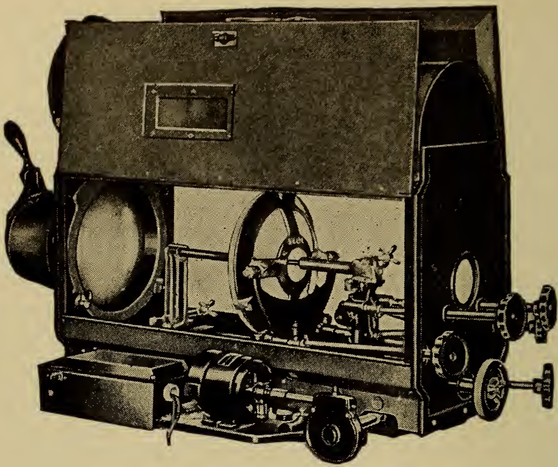


Fig. 315N

View of Motiograph Reflector Arc Lamp and Lamphouse

they are most frequently used, but a special insert for the negative holder and a special clamping member for the positive enables you to use the smaller carbons where the lower current values are employed. They may be ordered separately, or you may order the lamps supplied with them.

ARC LENGTH.—The arc must be adjusted to that length which gives the best results in screen illumination. From one-eighth to three-sixteenths of an inch for from 15 to 20 amperes and from three-sixteenths to one-fourth of an inch for twenty to tweny-five amperes is the range for best results. The arc control may be adjusted to maintain the desired arc length by means of the adjustment screw and lock screw at the front end of the arc control housing.

THE LIGHT SOURCE.—The crater on the positive carbon is the light source, and its perfect formation is of the utmost importance. One hundred per cent efficiency may only be had when the crater is well formed and faces the reflector squarely. If the crater slants off up and down or sidewise, there is loss of light in exact proportion to the seriousness of the fault. A slant sidewise is proof that the carbon tips are not in line with each other sidewise. If the slant be up and down, then the negative carbon tip is too high or too low with relation to the positive. The more nearly you can adjust your carbon tips to produce a crater having a perfect saucer shape which faces the reflector squarely, the better will be the results in screen illumination.

The adjustment of the negative carbon tip controls the crater formation. You may raise, lower or swing it sidewise by means of the adjustment handles.

ADJUSTING THE ARC CONTROL.—BEFORE ATTEMPTING AN ADJUSTMENT OF THE OPTICAL TRAIN AS A WHOLE it is essential that the arc control be regulated so that the necessary arc length is maintained, and that the carbon tips be so adjusted with relation to each other that the crater is formed as per directions under the previous paragraph.

To regulate the arc length, first open the switch on the arc control box. This switch is open when the white lines near the lever are out of sight. Then strike the arc. If the carbons be new ones, permit the arc to burn until the crater has fully formed. White this operation is taking place, viewing the arc through the lamphouse door observation window, so adjust the carbon tips that the crater forms in perfect shape, as before described, and so that it faces the reflector squarely, feeding the carbons by hand meanwhile.

When you have the crater burned in and in the best possible form, close the arc control switch, thus putting the controller into operation. Next, loosen the thumb screw over the controller adjusting screw just enough to permit of turning the latter. Adjust the arc to correct length by hand and turn the arc controller adjusting screw in or out until the controller just stops operating when the arc length is the right length. Now tighten the wing lock nut on the carbon feed screw and permit the controller to operate, making any further refinement of adjustment by means of the adjustment screw later. When you have the adjustment so that the controller maintains the desired arc length, tighten the thumb screw to lock the adjustment screw and the job is finished. Turning the adjustment screw in shortens the arc length; turning it out lengthens the arc length. The adjustment is a very sensitive one, hence you must exercise care in making it, but once made it should require no further attention for a long period of time.

ADJUSTMENTS INSIDE THE CONTROLLER.—The mechanism inside the arc controller housing is correctly adjusted at the factory. YOU ARE CAUTIONED AGAINST ATTEMPTING ANY CHANGE. It should operate indefinitely without attention, except that after a long period of time the contact points of the relay may require cleaning. To do this, first back off the adjusting screw directly above the spring connecting the relay armature with the arc-length-adjusting screw. Then press the relay armature with a finger to separate the contact points. Insert between them a piece of OO (called "double O") emery cloth, or paper, so folded that the emery side will face both points at the same time. Draw this gently back and forth between the points, at the same time pressing the points together with the fingers, until they are clean, smooth and bright. When this has been accomplished, repeat the process, using a piece of tough paper instead of emery paper, in order to remove all emery dust adhering to the points.

Next re-adjust the adjusting screw so that there is just sufficient space between the points, when they are separated, to break the motor circuit of the controller. THIS IS ONLY ABOUT SIX ONE-THOUSANDTHS OF AN INCH. Under no circumstances disturb the adjusting screw located over the magnet coils. This is set at the factory and the adjustment there made is PERMANENT.

OPTICAL ADJUSTMENT.—Caution: Do not attempt to make this adjustment until the foregoing instructions have been fully carried out, a perfect crater obtained, the proper arc length established and the arc controller regulated to maintain it.

When you have those various things done, open the lamphouse door, with the arc burning, and shove the entire reflector assembly ahead until the light shows all the way around on the metal of the condenser holder. By means of the reflector adjustment handles, move the light beam upon the condenser, if necessary, until it shows exactly the same amount on the condenser holder all the way around. In other words, center the light beam exactly on the condenser.

When this is done draw the entire reflector assembly to the rear, without disturbing any of the adjustment handles, until the beam of light just fills the condenser opening, and no more, whereupon tighten the thumb screw upon the reflector carriage to lock the carriage in permanent position, from which it should not again be moved.

Next observe the spot at the aperture cooling plate. If it does not center correctly DO NOT ADJUST THE MIRROR

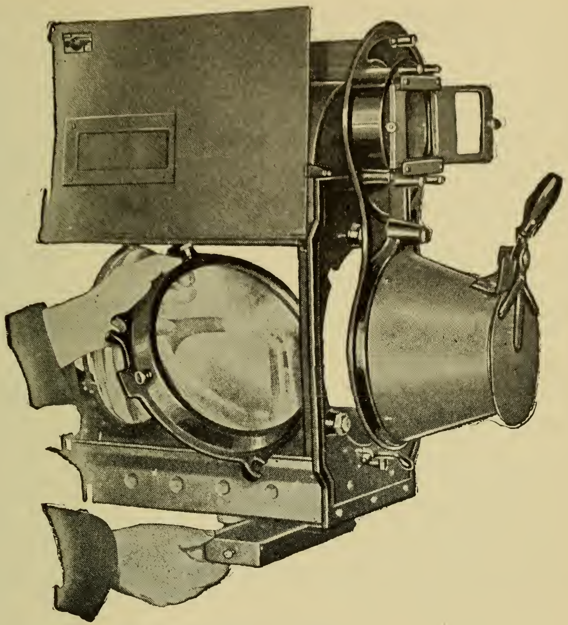


Figure 315-O
Showing Details of Condenser Mount

TO CENTER IT; also pay no attention to the size of the spot at this time. Slide the lamphouse one way or the other until the spot is centered sidewise, and adjust the stop collar on the round slide rod until it is against the sliding base attachment.

If the spot be now too high or too low, raise or lower the whole lamphouse by means of the four knurled adjusting nuts on the studs underneath the lamphouse base, and between it and the sliding base attachment, until the spot is correctly centered as to its height. **IMPORTANT:** In doing this be certain that nuts are moved equally, in order that the lamp be kept in correct relation to the axis of the optical train of the projector, which is an imaginary line from the center of the reflector to the center of the screen, upon which the reflector, light source, projector aperture and projection lens must be accurately centered.

When the foregoing has been completed, without film in the projector, raise the automatic fire shutter, block it up, turn the flywheel until the rotating shutter has uncovered the projection lens, and project the white light to the screen. Move the lamphouse backward and forward until the point is found where the light upon the screen has even distribution, and is at maximum brightness, whereupon lock the lamp carriage in this position.

The size of the spot is now the size which should be maintained in projection. Should it be somewhat larger than you have been accustomed to when using the regular arc, do not reduce its diameter under the impression that you are losing light. If you have followed directions correctly you have your optical line-up at the point where it gives maximum results in screen illumination. KEEP IT THAT WAY.

OPERATION OF STEREOPTICON ATTACHMENT.— The method of handling the stereopticon attachment is simple. It is too obvious to require much explanation. When the attachment is in position for motion picture projection it is only necessary to release the latch at its bottom and pull the attachment toward you until it automatically locks into position for slide projection. Reverse this action when it is again desired to project motion pictures. The dowser on the cone for motion picture projection reverses and acts as the dowser for slide projection also.

If the installation has been properly made the slide image should line up properly on the screen. Should it not, then with a slide in place in the carrier, loosen the two screws which attach the plate carrying the slide carried to the stereopticon auxiliary lens holder and shift the carrier until the image is square on the screen, whereupon tighten the screws firmly. Should you be unable to secure sufficient adjustment by this means, additional movement of the screen image may be accomplished by raising or lowering one side of the lamphouse by means of the four knurled adjustment nuts under the lamphouse. Raise one side and lower the other an equal amount in order to avoid disturbing the centering of the spot at the aperture.

CARE OF EQUIPMENT.—Keep lenses and reflectors scrupulously clean, see page 831. A foggy reflector means heavy loss in efficiency.

The manufacturer recommends that no lubricant be used on the lamp except Motiograph Arc Lamp Lubricant, and that even this be used very sparingly. Bearings which have oil holes should be lubricated with the same grade of oil used for the projector mechanism.

CAUTION.—Do not loosen stop collars on carbon clamp screws. They are set in correct position at the factory. The clamping action of the carbon jaws is very powerful. Too much pressure will result in crushed carbons, or broken parts. For the same reason, do not use plyers on the clamping wheels. Use your fingers. The parts do not become too hot for them.

WARNING.—If you want good results do not "monkey" with the arc controller mechanism. Except for the arc length adjustment, the mechanism is correctly adjusted at the factory and you cannot possibly improve that adjustment.

WARNING NO. 2.—THE MANUFACTURER RECOMMENDS THAT YOU DO NOT USE IN EXCESS OF TWENTY-FIVE (25) AMPERES OF CURRENT, for the reason that the designers of the optical system of the lamp advise that little or no increase in screen illumination will result from higher current. This is because of the fact that any additional light must come from the added area of the crater caused by the increased current, and the reflector cannot utilize the light from a crater area larger than that provided by twenty-five amperes of current, D. C. of course.

TRIMMING THE CARBONS.—The lamp functions at its best, only when the light source (crater) is exactly the right distance from the reflector. It therefore is essential that when trimming the carbons, the positive carbon tip be set EXACTLY the right distance from the reflector.

The directions of the manufacturer on this item, read as follows: "When inserting a new trim of carbons, take notice of the distance the crater is from the front edge of the mirror. Insert your new trim so that the point of the positive carbon is at this distance, and only a slight adjustment for spot size will be necessary. A mark on the lamphouse wall opposite the correct crater position may be made, as a guide for inserting new trims."

This method will approximate a correct setting, but we prefer the greater accuracy used by most projectionists, as follows: With the arc burning normally, and the crater in the best possible position, shut off the arc and measure the exact distance from face of reflector, beside its central hole, to face of crater. Cut a small piece of wood the exact length of this measurement, and attach it to the lamp base with a bit of wire or cord.

When placing a positive carbon in position, set one end of this bit of wood against the face of the mirror, beside its central hole, and bring the end of the positive carbon against its other end. You will thus have only a very slight readjustment to make, if any at all, when the crater is burned in on the new carbon.

When the positive is thus set, the negative tip should be brought to within about three-sixteenths of an inch of the face of the positive. You will soon learn to judge the exact distance the tips should be apart in order to bring the crater into exactly the right position when the trim is burned in.

THE MORELITE REFLECTOR ARC LAMP

The Morelite lamp is of the non-condenser type. Its mirror is six and five-eighths (6⅝) inches in diameter. The correct distance of the light source from the surface of the mirror, at its center, is three and three-quarters (3¾) inches. It therefore utilizes an angle of approximately 95 degrees of the available light.

The apparatus is well built and the lamphouse well ventilated. The lamp is wired with No. 6 asbestos-covered up to its binding posts. On the whole the design of the apparatus is good. The arc control operates on the well understood principle of rise and fall of arc voltage. Where the lamp is well and efficiently handled, the results are excellent.

INSTALLATION.—Set the lamphouse, together with its base, on the projector stand, and secure in position so that the front lamphouse wall is twelve (12) inches from the projector mechanism aperture.

Install the mirror (first having cleaned it carefully, see page 831) by loosening jointed prong D, figure 315P, which permits of its insertion into the holder, and its proper seating in the other retaining prongs. Bring jointed prong D forward as far as possible, allowing about one thirty-second (1/32) of an inch space between the prong and the mirror edge, in order to permit of expansion of the glass, under heat, without binding.

Next move carbon rack E, figure 315P, forward, by means of handle F, Figure 315P, until the carbon clamp protrudes through the hole in the center of the mirror, and adjust the

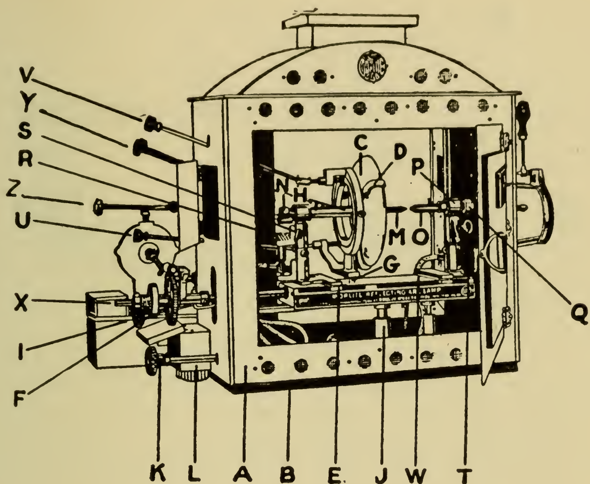


Figure 315P

mirror by means of adjusting screw G, figure 315P, so that the clamp, or carbon holder, is exactly centrally located in the hole in the mirror.

It is essential to good results that this adjustment be made accurately, and you may best do it by making a small mark or point exactly in the center of the tip of an unburned carbon, clamping the carbon in the holder and so adjusting the carbon holder backward and forward, that the tip of the carbon is flush with the surface of the mirror. By using an ordinary carpenter's divider, or draughtman's compass, you may, by setting one point on the mark you have made in the center of the carbon tip, and scribing the edge of the hole in the mirror with the other, make the adjustment accurately.

NOTE.—It will be well to retain the carbon you have used for this adjustment so that, with small trouble, you may make an occasional test of the centering.

Next turn handle I, figure 315P, until the mirror is approximately in the center of the carriage casting. By means of handle K, figure 315P, raise or lower the entire lamp until the distance from the base upon which the projector mechanism rests, to the projector mechanism aperture, is the same as the

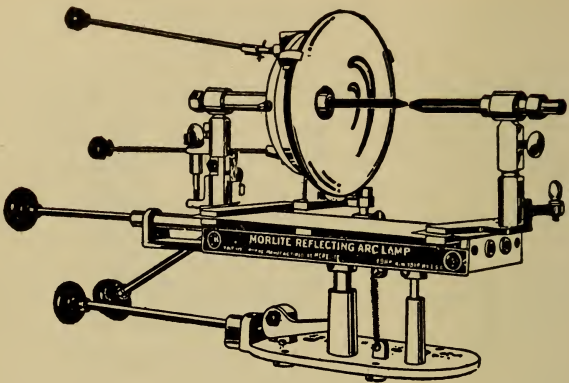


Figure 315Q

Details of Morelite Lamp

distance from the base upon which the lamphouse rests to the center of the hole in the mirror, or the center of the carbons. This brings the lamp into proper vertical alignment with the projector aperture and projection lens.

Now raise the cover of the small metal box, L, figure 315P, at the rear of the lamphouse, and connect the feed wires to the terminals. IF USING DIRECT CURRENT, be very certain that the positive wire connects to the front carbon holder, the negative being the carbon which protrudes through the [illegible] in the mirror.

If, after making the connections, the carbon next the mirror gets much hotter than the other, and its end burns flat or saucer-shape instead of to a point, and the light is very poor indeed, you have connected the wires wrongly, and must reverse them.

CARBON SIZE.—If you are using 20 to 25 amperes, use a solid negative carbon 5/16 of an inch in diameter, together with a cored positive 15/32 of an inch in diameter. If the amperage be 10 to 20, then use a 9/32 or an 11/32 solid negative, according to whether the amperage be above or below 15, with a 3/8 inch cored positive. Clamp carbons in their holders firmly, using special wrench supplied with the lamp for the purpose.

IMPORTANT.—So place the negative carbon that its tip will be EXACTLY 3¾ inches from the surface of the mirror at its center. This is very important, and you must not be careless in the matter if you expect to get maximum results from the lamp. You may best work to exact accuracy in this matter by cutting a small piece of soft wood, just 3.75 inches long. When trimming carbons set one end of it gently against the mirror surface beside the carbon, and bring tip even with its other end.

Having adjusted the negative, place the positive in position so that its tip is in contact with the negative tip, so adjusting the carbons, by means of the control handles, that their tips are in exact line sidewise, but with the negative tip approximately 1/16 of an inch lower than the positive tip, so that the crater will burn as at A, figure 315A. The controls which permit of this adjustment are R, S and T, figure 315P. When adjustment is accomplished to your satisfaction, clamp tightly because it should never be altered, unless for some reason, in the course of time, the carbons get out of alignment. This is not likely to occur, but is possible, and the alignment should occasionally be tested.

PROPORTIONS OF CARBON TRIM.—Never so trim the lamp that the proportions of positive and negative carbon lengths exceed two of negative to one of positive. FAILURE TO OBSERVE THIS MAY RESULT IN A BURNED CARBON HOLDER. In order to make this still more clear, allow two inches of negative carbon to each one inch of positive carbon between the carbon jaws. In order to compensate for the difference in carbon consumption as between positive and negative, it is only necessary to make slight adjustments by means of handles O, V, I and F, figure 315P.

TO STRIKE THE ARC.—Pull outward on knurled knob F, figure 315P, which act disengages the controller mechanism, and thus permits feeding the carbons by hand. Separate the carbons an eighth of an inch or so, close the projector table switch, bring the carbon tips together, separating them again immediately. Let go the knurled knob, which act will automatically re-engage the arc control mechanism. Next push down brass toggle switch on the arc control box, which act starts the arc controller mechanism into operation.

ARC LENGTH ADJUSTMENT.—(See page 830.) The length of the arc gap may be altered to meet the demands of the work by turning the knob found on the outside of the arc controller housing. Turn it in either direction, observing the results, until the point is found where the desired arc length is maintained.

ADJUSTMENTS.—Turning knob Y, figure 315P, moves the negative carbon holder sidewise. This adjustment is useful to center the carbons in case of a warped positive or negative carbon. Knob Z, figure 315P, moves the negative carbon holder up or down. Make any necessary adjustments by means of knobs Y and Z, and NEVER DISTURB THE POSITION OF THE POSITIVE CARBON HOLDER, ONCE IT HAS BEEN CORRECTLY ADJUSTED SO THAT THE CARBON CENTER IS ON THE AXIS OF THE OPTICAL TRAIN.

Tilt the mirror, as may be desired, by means of handles U and V, figure 315P. The spot at the aperture is centered thereon by tilting the mirror. Move the mirror backward or forward, by means of handle I, figure 315P, until the spot at the cooling plate is about two inches in diameter. Should the light beam strike the interior of the metal cone on the front of the lamphouse at any point, loosen holding screws and move the cone until it no longer interferes.

CLEANING REFLECTOR. MANUFACTURER'S RECOMMENDATION.—The mirror should be cleaned at least once each day it is used. Clean it ONLY while it is cold. Use ONLY a soft, dry cloth, or soft tissue paper. Should spots appear on the surface of the glass, same may be removed by means of a cloth dampened with gasoline or benzine. Never attempt to handle a hot mirror, or permit drafts of cold air to strike it.

The spherical mirror of the Morelite is 3¾ inches (three diopters) in focal length, which means that its rear surface is the true section of a hemisphere. In other words, if the points of a draftsmen's divider be spaced 3.75 inches apart, one point placed on paper and the section of a circle 6⅝ inches long be scribed with the other point, the resultant curvature would be exactly the curvature of the outside, or reflecting surface of the mirror, in any direction across its surface.

The mirror vertex (center) should be approximately nineteen (19) inches from the projector aperture—APERTURE, not cooling plate—of the projector mechanism.

CLEAN LAMPHOUSE.—A small opening is provided in the bottom of the lamphouse for the removal of carbon dust, dirt, etc. The entire lamp and lamphouse should be kept clean. Especially do not permit carbon ash to clog the lamphouse ventilation, which it may do, since the same is covered with a screen. If you do not keep the ventilation open and free, you will have excessive heat in the lamphouse, and YOU and NOT THE MIRROR will be to blame if its backing does not stand up under such ABUSE.

LUBRICATION.—The moving parts of the lamp must be kept lubricated, using a good grade of oil where it is not subject to high temperatures. On the carbon clamp screws and parts subjected to high temperature use only powdered graphite. Dip the screws or parts into kerosene, or some very thin oil, and then into the graphite powder. The oil is merely to cause the graphite to adhere to the metal until the part can be replaced.

The arc control parts must be lubricated with good oil, the same as you would lubricate any other small machinery. There is no set rule as to how often. Use common sense.

The Morelite lamp insulation is of high grade mica and lava. The large plate which covers the burner mechanism is covered with a special insulating material. By removing two small screws you may remove this cover to clean and oil the threaded spindles, which should be done about once per month.

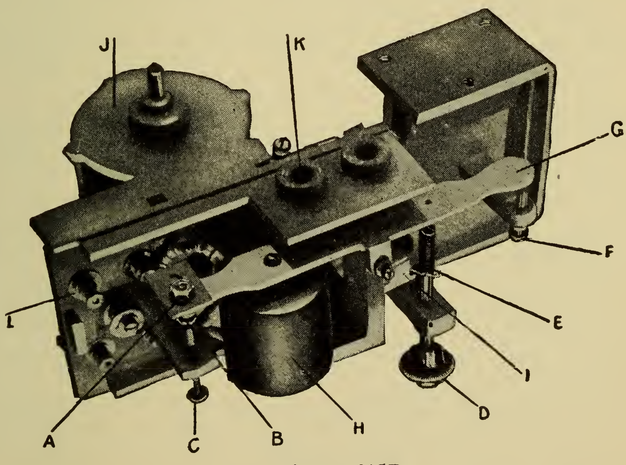


Figure 315R.
Details of Morelite Arc Controller

THE ARC CONTROL operates on the constant or potential principle, so that any change in the arc voltage from the predetermined value for which the controller is set, either starts or stops the motor which feeds the carbons together.

Figure 315R is a view of the controller mechanism, with the protecting cover removed. The controller, as a whole, consists of a base casting bolted to the wall of the lamphouse. On this casting the actuating motor is mounted, together with a gear reduction box and a universal joint. On the under side of the casting the relay contacting system is mounted. This consists of magnet H, armature G, motor contacts A and B, armature controlling spring E, spring adjusting screw D, which latter protrudes through the assembly cover, armature travel limit screw F, main terminal L and insulating bushings K.

The principle upon which this device operates is explained, in detail, on page 608, and is illustrated in figure 208. The device is extremely sensitive in operation. Adjustments for arc length are made by means of adjustment screw D, figure 315R. Turn this screw a very little at a time, until the arc length required is attained.

Sometimes the control operates a bit stiffly after standing all night. This, however, after it is put into operation for a time, corrects itself.

A thin grease should be injected into the gear housing when required, and all moving shafts and sleeves, and the worm must be lubricated, using good oil, just as you would oil any light machinery.

WARNING.—A careful watch should be kept on the lamp to be extinguished when the lamps are in series for changeover, lest it go out prematurely. The best way to avoid this danger is to feed the arc a bit shorter by hand.

CHANGE ADJUSTMENT IF AMPERAGE IS CHANGED.—Since arc potential changes as arc amperage is increased or decreased, it will be found necessary to alter the adjustment of the tension of spring E by means of the adjustment screw D, should the amperage be raised or lowered in any considerable degree. A further explanation will perhaps be not out of place.

The controller consists of solenoids which are connected "across the arc." That is to say, one of the solenoid terminals connects to positive and the other to negative of the arc lamp circuit, on the lamp side of all current control apparatus—to all intents and purposes to the lamp terminals themselves, though that is not actually done. The 1/75th H.P. motor which drives the controller has its electrical circuit broken by a contact point placed in a magnet armature.

This magnet, being energized by the arc voltage, it will of course be understood that as the arc voltage is increased or diminished, the pull of the magnet on its armature will also be increased or decreased. For an explanation of the principle involved see page 608.

In practice this means that as the arc voltage increases because the carbon burns away, increasing the arc length, the pull on the magnet armature held away from contact by the spring becomes greater and the tension of the spring is overcome, the armature pulled into contact and the motor started, the carbons fed together, the arc voltage thus decreased until the spring again overcomes the pull of the magnet and opens the circuit, stopping the motor, and so the process is repeated indefinitely.

Of course there really is a slight variation in arc length under this plan, as is readily seen, but it is so very small that it cannot be noticed, so that the distance between carbon tips may, for all practical purposes, be said to be constant.

The arc is first struck and adjusted to about the right length by hand. Thereafter the action of carbon feeding is entirely automatic, except for the attention made necessary by the difference in rapidity of positive and negative carbon consumption.

The contact points have been carefully adjusted at the factory, and NO FURTHER ADJUSTMENTS ARE NECESSARY, EXCEPT THE NECESSARY SPRING TENSION REGULATION. In course of time, however, the contact points will, through unavoidable sparking due to making and breaking contact so often, become roughened. They should then be carefully polished with No. 0 emery cloth. Do NOT use emery cloth coarser than No. 0. Also in course of time the points will need replacing. You should therefore have spare points ready for use when needed.

If your controller continues to feed the carbons forward until they come into contact with each other (freeze) it indicates that the stationary contact points permits the movable contact point to come too close to the magnet, hence it should be screwed in, or towards the movable point.

When the controller no longer starts feeding the carbons at the proper point, screw in the rear screw until the contact points are about 1/32 of an inch apart, whereupon the proper regulation may be had with the adjusting screw. The motor and magnet are protected by a three-ampere cartridge fuse. Should the controller refuse to function, put in a new fuse. SPARE FUSES SHOULD BE KEPT ON HAND.

TO OPERATE BY HAND.—To feed the carbons by hand, merely cut out the controller by means of the toggle switch on its top.

THE RHEOSTAT.—With the rheostat supplied with the equipment you may use either 10, 15, 20 or 25 amperes, at will, but bear in mind the fact that 25 amperes D C will, if you have the equipment properly adjusted, supply screen illumination equal to that supplied by a 75 ampere D C regular arc with the old type arc. Provided the line voltage be not in excess of 110, the rheostat will deliver 10 amperes with both switches open, 15 when the switch marked 15 amperes is closed, 20 amperes when the 20 ampere switch is closed and 25 amperes when both the 15 and 20 ampere switches are closed. The statement of comparative illumination is the manufacturer's claim.

STEREOPTICON ATTACHMENT.—The stereopticon attachment consists of a metal box about 14 inches long by 6 inches square. This box is attached to the front left hand corner of the lamphouse, at about the center of the attachment box, by means of two ordinary iron hinges. Inside of this attachment box are two movable metal plates, one at either end, each carrying a mirror.

The mirror which faces the light source when the attachment is in use, is of metal, highly polished, and slightly convex. The other mirror is plain flat glass, about 4 inches wide by 6 inches long. These mirror holders are both adjustable. The convex mirror facing the light source is, by means of knurled thumbscrew on the side of the box, so adjusted that it reflects the light to the flat glass mirror at the other end of the attachment. The flat glass mirror is then adjusted, by means of two knurled thumb-screws, so that it reflects the light through a plano convex single lens condenser, held in front of the slide, and thence onward into the projection lens.

All this sounds quite complicated, but is really very simple. The attachment is placed permanently and locked in place by means of the hinges and a conveniently located latch. When it is desired to project motion pictures, the convex mirror is merely moved back against the end of the box, which leaves the light beam unobstructed. The change from motion pictures to stereopticon projection, or vice versa is made in something like 2 seconds. The attachment carries a dowser with which the light beam may be shut off from the film in motion picture projection. When it is desired the whole attachment may be swung around out of way, merely by unloosening the latch.

THE STRONG LAMP EQUIPMENT

The "Strong" reflector type arc lamp and its equipment is well designed and rugged in its construction. Its various operating controls are excellent and adequate. Its stereopticon attachment is easy of manipulation, in that one movement makes all necessary alterations in the optical train to change from motion picture to stereopticon, and vice versa.

The arc controller is very simple in construction and unique in operation in that its motor armature depends upon a magnetic balance for its action, and will rotate in one direction if the voltage across the arc rises, but in the opposite direction if it falls below the predetermined value for which the device is set, which means that it will feed the carbons forward if the arc voltage rises because the arc gap is greater than what the controller is set for, or separate them if the opposite condition obtains.

The controller is merely a small motor consisting of an armature with field poles carrying a compound winding, one winding of which is heavy wire carrying the entire arc amperage. The other winding is connected directly across the arc, hence carries the arc voltage. These windings are so connected that their magnetic fields oppose each other, and when the arc voltage, hence the arc length, is exactly at the value the controller is adjusted for (adjustment changes may be made by the projectionist), the magnetic fields of the two windings exactly balance each other, hence there is no magnetic action upon the motor armature, which ceases to rotate until the arc voltage either rises or falls, whereupon the controller will feed the carbons forward or separate them further apart until the magnetic fields again balance, hence the arc length is exactly re-established. The plan secures very close arc length regulation, also it has the virtue of being quite simple. The purchaser should, however, advise the manufacturers' agent of the kind, voltage phase, etc. of the local current supply, and be assured that the controller will operate successfully under the local conditions.

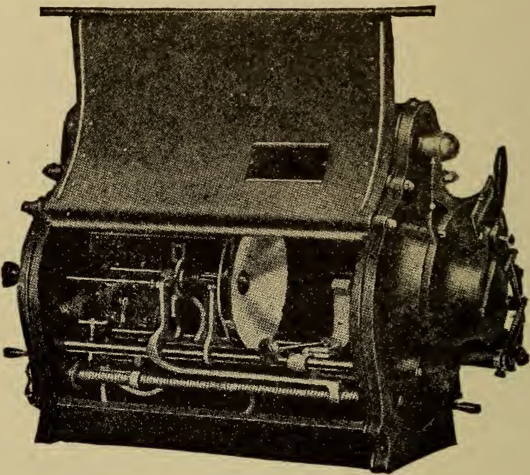


Fig. 315S
Strong Lamphouse Showing Lamp Controller and Adjustment Knobs

UNPACKING.—When the lamp equipment is received in its packing case, lay the case upside down on the floor and remove the screws, the heads of which you will see in the bottom boards of the case. Then lift the entire bottom of the case, with lamphouse attached thereto, straight up, and turn it right side up. Next remove the nuts of the bolts holding the lamphouse to the case bottom. They are inside the lamphouse.

In a separate compartment at one end of the case you will find the mirror, rheostat and other necessary fittings.

SETTING UP.—To install the equipment on a Simplex projector it is only necessary to remove the two wingnuts on the under side of the lamphouse table, which releases the Simplex lamphouse. Remove it and substitute the Strong lamphouse, clamping it on the table with the same two wingnuts.

For installation on projectors other than the Simplex, a special adapter base is supplied, which must be attached to the base of the Strong lamphouse by means of screws. It is then only necessary to remove the regular lamphouse from the rods upon which it slides sidewise, and to mount the Strong lamphouse in its place.

IMPORTANT.—So locate the lamphouse that the center of the mirror is twenty-two (22) inches from the projector aperture. This measurement is not necessarily exact. There is a permissible tolerance of as much as two (2) inches either way, but it is well to have it pretty close to the indicated distance.

Having located the lamphouse as above, place the mirror in position in holder 2302, Fig. 315U, by hooking mirror under clip 2309, Fig. 315U, and clamping it in place by means of clip 2312, Fig. 315U. Next, so adjust the mirror that when the spot is centered on the projector aperture the light beam is central, sidewise, in the lamphouse cone.

Facing the screen the right hand wire at the rear of the lamphouse connects to the positive carbon and the left hand one to the negative.

IMPORTANT.—Before disconnecting the old lamp (assuming it is not to be new equipment throughout) note which side of the projector table switch the positive and negative connects to and connect the wires from the new lamp the same way. If it be a new installation throughout, and you have no knowledge of which is positive and negative, then secure a raw potato, cut it in half and stick the raw end of both wires into it, about one inch apart. Close the switch and soon there will be a discoloration around the NEGATIVE wire, and you may mark the wires and connect accordingly. Or you may install carbons, strike an arc, let it burn a few minutes and when it is extinguished the carbon which is the hotter is the positive.

NO LOAD VOLTAGE.—The lamp should be supplied by a power source having a no-load voltage of not less than eighty (80). This is of importance only where a generator not especially designed for reflector type lamps is used. By "no-load voltage" is meant the voltage the generator produces when there is no load attached thereto.

Except where current is supplied by a generator especially designed for use with reflector arc lamps, current must be controlled by means of a rheostat, which should be of the adjustable type, so that the projectionist may alter or control the current flow.

AMMETER SUPPLIED.—A reliable ammeter is installed in the rear casting so that the projectionist may govern the current flow with the accuracy necessary for best results.

ARC VOLTAGE.—The most satisfactory voltage across the arc is fifty-four (54) when using twelve (12) amperes, gradually increasing until when the maximum current flow of twenty-eight (28) amperes is being used, the voltage is about fifty-seven (57).

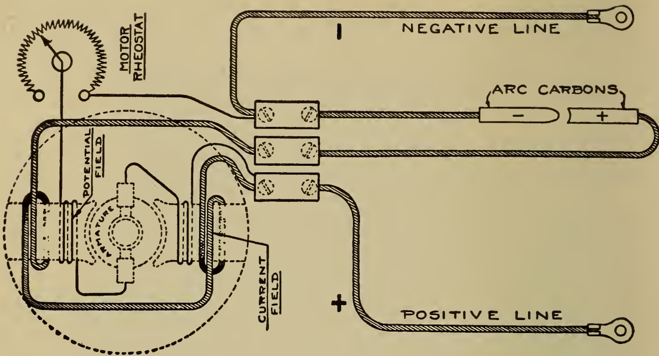
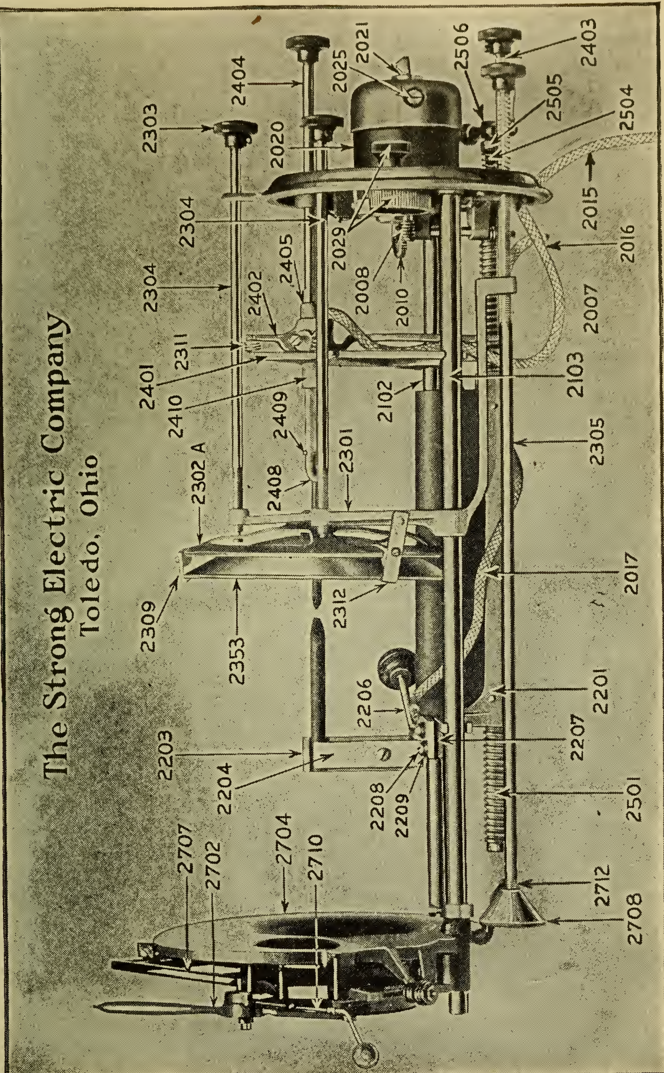


Figure 315T
Illustrating Wiring of Strong Arc Controller

CARBON SIZES.—Amperage varies under different conditions, and of course the same size carbon will not answer for all amperages. As a matter of fact if efficient results are to be attained the carbon size must "fit" the amperage used, with only a very small tolerence. The average theatre will probably find fifteen to sixteen amperes sufficient, PROVIDED THE CORRECT CARBON DIAMETER BE USED, which is ten (10) millimeter cored positive and 7 millimeter solid negative for that current strength.

Let it be clearly understood, however, that these diameters are only highly efficient for from say 14 to 17 amperes. If more or less current be used, then carbon diameters must be changed or efficiency will fall sharply. If your carbons, or either one of them burns to a long, sharp point (called "penciling), you are using too much current for their capacity. They are overloaded. You must either reduce the amperage or install larger carbons. Penciling always starts with the negative, but if only the negative pencils and you change to a larger negative, you must also use the larger positive which goes with it. If you do not you will not be working well or efficiently. For correct carbon sizes and combinations, see page 400½.

STARTING.—The arc controller connects to the carbon feeding mechanism by means of friction disc, 2504, Fig. 315U. In order to feed the carbons by hand it is not necessary to disconnect anything, but merely to rotate crank handle 2506, just below and to right of the controller motor.


The Strong Electric Company
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2708

Fig. 315U

To install the carbons, first rotate crank handle 2506, Fig. 315U, counter clockwise until they separate as far as possible. The positive carbon is then placed in carbon jaw 2203, Fig. 315U, until the rear end of the carbon is even with the back side of the jaw, as shown in Fig. 315U. The carbon is clamped into place by means of knob 2206, Fig. 315U. To install the negative, pass its back end through the mirror and into the negative carbon jaw. To do this you place a finger behind the carbon, and with the carbon pull spring 2408, Fig. 315U, open, shoving the carbon back as far as it will go, which is against stop pin 2409.

CAUTION: If you attempt to pull the spring open by placing the finger anywhere else but as close as possible to the end of the carbon, you may and probably will merely succeed in breaking the carbon.

Having thus installed the carbons, you must make sure that their points are centered with each other, which may be done by means of control rods 2403 and 2404, Fig. 315U.

To strike the arc, separate the carbon tips slightly and close the projector table switch, whereupon if everything is as it should be, the controller motor will start, whereupon you may feed the carbons forward into contact by means of crank 2506, quickly separating them again, and ascertaining by experiment the arc length which will give the best screen results.

ADJUSTING ARC CONTROLLER.—To adjust motor control to maintain the desired arc length, have arc burning normally at proper arc length for best results, and turn rheostat handle 2029, Fig. 315U, until the controller motor armature shaft 2021, Fig. 315U, revolves clockwise (to the left), very slowly. This condition signifies correct adjustment, but should further adjustment be necessary it may be made at any time by means of knob 2029. Turning this knob clockwise has the effect of decreasing the carbon separation and vice versa.

CLUTCH TENSION ADJUSTMENT.—The tension of the friction clutch connecting the arc controller to the carbon feeding mechanism may be altered at will by means of nut 2505, Fig. 315U. It should, of course, be only tight enough to operate the carbon feeding mechanism.

The mirror may be adjusted to center the spot on the projector aperture by means of two knobs located at the rear of the lamphouse, one of which tilts the mirror vertically, while the other swings it sidewise.

To project stereopticon slides, shove the lamphouse over to the left and pull stereopticon attachment 2704, Fig. 315U, over into place. By means of cone 2708 this action also advances the mirror into position for stereopticon projection.

It is necessary that the mirror be thus advanced in order to secure uniform illumination of the slide. You will readily understand how the mirror movement is accomplished by watching the action when you pull the stereopticon attachment over into place.

With the slide carrier in place, project a slide to the screen and level it, see page 449, Volume I. So adjust the stereopticon lens that the image is in its correct position and in focus on the screen. Then, if necessary, loosen the locking screw holding cone 2708, Fig. 315U, and screw the cone further on or off the rod as may be necessary, until the light beam is exactly centered in the projection lens, whereupon tighten the lock screw firmly.

THE HALLBERG REFLECTOR TYPE PROJECTOR ARC LAMP

The Hallberg Reflector Arc Lamp consists of a complete lamp house unit, including arc lamp with automatic motor-

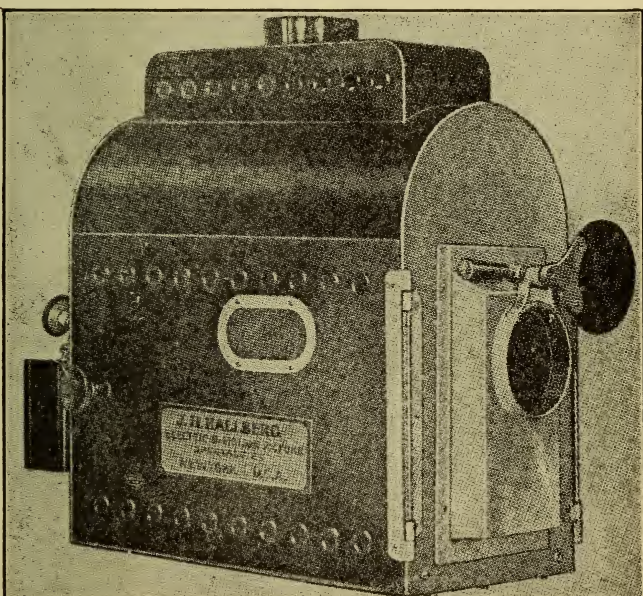

Figure 315V

driven carbon feed apparatus and adjustments, therefore, all complete, assembled and ready for mounting upon any standard make projector, after the old lamp house has been removed.

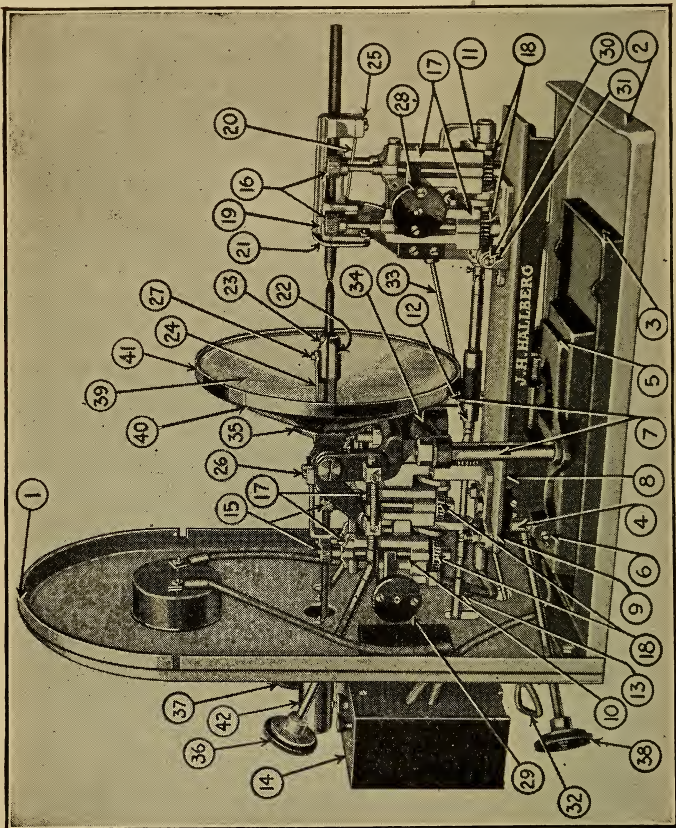

Figure 315W

Fig. 315V illustrates the external appearance of the complete unit and the illustration is self-explanatory. In the base, which is made of an aluminum casting, proper holes are provided for screws to hold the new lamp unit in place of the old one and the mounting can, therefore, be accomplished within a few minutes after the unit has been unpacked. The lamp house is amply ventilated and provided with standard 4⅛" flange on top for the vent pipe.

Fig. 315W is a three-quarter side view of the arc lamp, with the front aluminum casting and metal housing removed, which is readily accomplished by loosening of five screws in the top of the rear casting 1 and two bolts in front of the base casting 2. All figure numbers used herein refer to Fig. 315W or X.

The lamp is mounted as a complete unit on cast aluminum sub base 3 which is provided with limited adjustments in relation to lamp base 2. From sub-base 3 there extends 3 studs 4, upon these there rides, adjustably up and down auxiliary sub base 5 which may be locked in any position by screws 6. Attached to 5, there are two large studs 7 which support the adjustable reflector holder. On top of 5 there is a milled slot within which rides a milled projection on aluminum base 8, which supports a substantial asbestos board 9 upon which there is solidly and permanently mounted the carbon holder and feed mechanism head 10 for the negative carbon, and 11 for the positive carbon. These heads are coupled by insulated shaft 12 through universal joint 13 to automatic arc controller mechanism 14.

Each head 10 and 11 is provided with four knurled rollers 15, two on each side of the negative carbon and four similar rollers 16, two on each side of the positive carbon. These rollers are constructed from hardened steel and are designed to feed any standard size carbon. There is an independent guide 17 for each roller, flexibly mounted and all driven together at equal speed by shaft 12, through gears 18. This constitutes the feeding or separating system for the carbons when shaft 12 is rotated. The positive carbon is pressed against a heavy metal shoe 19 by a stiff flat spring 20, thus making direct and self-cleaning contact at point 21 with 1¼" of the positive carbon crater. This arrangement causes the voltage drop in the positive carbon to always remain constant, irrespective of the length of the trim. The negative carbon holder consists of a heavy fixed extension 22 with a "V" slot in which the negative carbon slides; on top of this there, is a metal shoe 23 with "V" slot pressing against the upper side of the negative carbon under tension of a powerful flat spring 24. This provides a self-cleaning constant contact of high electrical and heat conductivity for the negative carbon 1¼" from the arc. This arrangement keeps the voltage drop in the negative carbon constant, irrespective of the length of the trim. The positive carbon spring is held by screws 25 and the negative spring is held by screws 26 and anchored to the sliding carbon jaw by screw 27. When new carbons are inserted knobs 28 and 29 are turned to the left. This motion loosens rollers 15 and 16 and new carbons can be pushed into the sliding holders 21

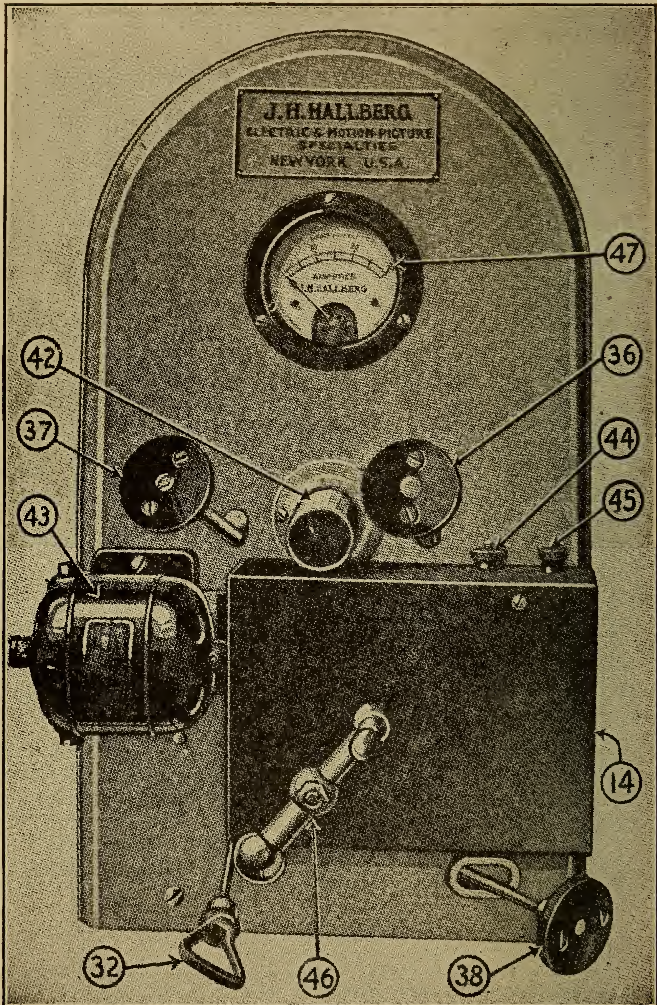
J. H. HALLBERG
ELECTRIC & MOTION PICTURE
SPECIALTIES
NEW YORK U.S.A.
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Fig. 315X

and 22. When the carbon points have been brought about ¼" apart, centered between 21 and 22, as illustrated, a half a turn to the right on knobs 28 and 29 locks the rollers 15 and 16 against the carbons. The positive head 11 is hinged on two pointed screws 30 with lock nuts 31 which permits the positive head to be tilted to the left by pulling out on handle 32 which, through rod 33 rocks the head bringing the positive carbon towards the negative, thus striking the arc when handle 32 is released. All the foregoing numbers will be found in figure 315W.

The reflector is supported on a heavy bracket 34 on which its frame support 35 is flexibly mounted to allow the control handles 36 to adjust the light beam up and down and handle 37 from side to side. Handle 38 moves frame 8 supporting carbon heads 10 and 11 back and forth allowing the arc to be brought towards or away from the reflector, thus insuring focusing of the spot at the aperture, in case the carbons should not have been put into the holders just right when trimming or if the crater should shift slightly due to uneven burning of the carbons while the lamp is in operation. The reflector 39 is loosely and flexibly held under spring tension in metal ring 40 and is removable by lifting up on spring 41. A new negative carbon is inserted through insulated tube 42 and simply pushed in through the guide and rollers after they have been loosened by turning handle 29 until it touches the piece of the negative carbon remaining in guide 22, then handle 29 is turned to the right engaging the feeding rollers 15 with the new carbon.

Fig. 315X illustrates the rear end of the lamp house and shows the few and simple adjustments necessary. Handle 32 is pulled out for striking the arc; handle 36 is for up and down motion of light beam. Handle 37 is for side adjustment of the light beam. 14 is the housing for the arc controller and 43, figure 315X is a motor for the carbon feed. 44 Figure 315X is adjustment nut for the arc voltage. 45, Figure 315X is the switch for motor 43. 38 adjusts the entire lamp back and forth in relation to the reflector. 46, Figure 315X, is the handle for feeding the carbons by hand, which is accomplished by simply pushing in and turning to the right or left, but when the handle is released it automatically engages the carbon feeding mechanism. 47, Figure 315X, is an ampere meter which can be provided in series with the arc and is a convenient addition to the equipment.

The lamp house is provided with two full size doors, colored and screened glass inserts in windows for viewing the arc. On front of the lamp house there is a dowser.

When it is desired to use this unit for stereoptican projection an unique arrangement is provided, but not illustrated, consisting of an entirely separate small arc lamp which swings out in front of the positive carbon head and uses the carbon stubs left over from the projector arc and is manipulated and fed with a handle extending just below the dowser. This duplex system provides 100 per cent. light efficiency for picture projection and also 100 per cent. efficiency for stereopticon slide projection.

The lamp has a capacity from 10 to 35 amperes, depending upon the size of the carbons and rheostats employed and the arc controller is adjusted to feed the carbons at any voltage between 40 and 60, the standard being 50 volts.

Mazda Lamp Projection

PROJECTION by means of an incandescent light source is no longer an experiment. Its practicability, within certain limits, has been very thoroughly established. Mazda lamp projection now is, and for a considerable time has been giving perfect satisfaction in a very large number of theatres.

In order to intelligently decide as to the advisability of substituting Mazda lamps for the arc lamp, it is necessary that the exhibitor and the projectionist have a good fundamental knowledge of the various things involved.

SOURCE BRIGHTNESS AND UTILIZATION OF LIGHT. —Let us first consider the possibilities of the two sources of light, from the view point of brilliancy per unit area, and the area of the light source itself.

The crater of the electric arc is the most brilliant source of artificial light evolved up to this time. This is because the floor of the crater of the electric arc is and must be raised to the temperature necessary to volatilize, or vaporize carbon, which is the hardest, most refractory substance known to science. The brilliancy per unit area of the ordinary projection arc crater (cored carbon) is between 132 and 160 candle power per square millimeter. What the brilliancy of the high intensity arc crater per unit of area is we do not yet know.

The Mazda light source cannot possibly equal the brilliancy per unit area of the electric crater, since the temperature necessary to produce such a result would instantly volatilize the lamp filament, and thus destroy the light source. In the Mazda lamp we therefore must be content with a light source much less brilliant, per unit area, than is the crater floor of the electric arc, but this is overcome to some extent by being able to locate it much nearer the lens.

Due to the relatively high brilliancy per unit area of the electric crater, it is not to be hoped that the Mazda lamp can or ever will furnish a screen illumination equal in brilliancy to that supplied by the high intensity electric arc. Just how nearly the Mazda lamp will be able to duplicate the performance of the arc is, however, a matter for future decision.

The problem of determining the possibilities with the Mazda lamp for motion picture projection purposes involves many things. The principal reason for this is that the area of a light source is limited so far as present procedure goes, when that source must be projected through a small aperture by a condensing lens, and the beam again picked up by a second lens system (projection lens) beyond the aperture.

Under conditions prevailing with the electric arc it has been impractical to use a light source of appreciably greater diameter than one half inch, and the same limitation has thus far prevailed with the Mazda lamp, but with this difference: due to the difference in heat, the Mazda light source may be, and is placed very much nearer a condenser lens than can be the crater of an electric arc of equal area, therefore the condenser will pick up a very much greater percentage of the total light (see Fig. 36H, page 162) when working with the Mazda lamp than when working with an electric arc.

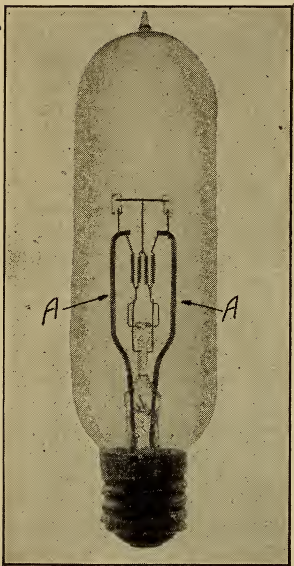


Figure 316

The use of a large projection lens diameter should, in theory, compel an increase in the width of the revolving shutter master-blade. That it does so may be disputed by some because of the fact that many projectionists change from a small to a large diameter projection lens without any apparent necessity for altering the revolving shutter master-blade. As may readily be understood by all, this is true with the arc as well as with the Mazda lamp, but it in no way alters the truth of the proposition that the larger diameter lens requires a wider master blade than the smaller diameter lens. It simply means that the projectionist was using an unnecessary width of master-blade while using the smaller diameter lens. In other words, while using the small diameter lens he was using a master-blade wide enough for a large diameter lens, hence was working unintelligently and wastefully.

The foregoing may not sound very impressive, but it nevertheless is a fair statement of the main elements of the problems involved, when it comes to a comparison of the electric arc and the Mazda lamp as a motion picture projection light source.

Since the Mazda lamp filament is in fixed position, a glass mirror reflector, spherical in form, is placed behind it,

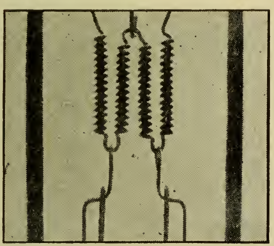


Figure 317.

Figure 318.

which reflects through the spaces between the filament coils a large percentage of the light which would otherwise not reach the condenser, and hence would be wasted.

THE MAZDA MOTION PICTURE PROJECTOR LAMP.— In Fig. 316 we see one of the latest Mazda motion picture projector lamps illustrated, and in Fig. 317 we see the filament thereof at exactly full size. A A, Fig. 316 are the supports for the filament, which supports are current carrying and of opposite polarity.

The support of the filament has been one of the most serious problems encountered by Mazda lamp engineers. The reason this point has caused so much trouble and vexatious delay in the perfection of the Mazda projector lamp is that the four coils must be held perfectly straight, so that as a whole, they present an even, flat surface to the collector lens. This seemingly simple thing proved to be an exceedingly difficult problem, because of the fact that the filament is subjected to very heavy expansion under the high temperature at which it must operate, contracting to normal length again when it cools off. This alternate expansion and contraction occurs frequently, every time the lamp is started or stopped, hence unless the coils be supported in precisely the right way they are likely to sag, warp or partially short-circuit, as shown in Fig. 318. If this occurs it of course either entirely ruins the lamp or else very greatly impairs its efficiency, depending on how great the fault may be in the individual case.

Mazda lamp engineers have finally, however, pretty well solved the problem, and a filament is now used which is of such composition and has such support that it is very dependable. True, an occasional coil still will fail, and probably always will, but they are few, and the lamps are guaranteed, within certain limits against such failure.

Figure 319.

HOW THE MAZDA LIGHT SOURCE IS MADE UP.—The Mazda motion picture projector lamp light source is composed of four coils of tungsten wire. These coils are wound exactly the same as are ordinary coil springs, or rheostat coils. Their exact size and length may be seen in Fig. 317. The base of the metal used is either a pure, or very nearly pure tungsten.

As will be seen by examining Fig. 317, the coils are separated from each other by a distance equal to a little less than their own diameter, and the four coils, as a whole, are so suspended and held that they present a perfectly flat surface to the face of the collector lens.

From the foregoing it will be understood that the Mazda

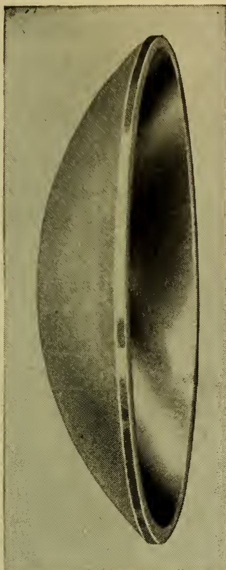


Figure 319½.

lamp composed of wire coils cannot possibly in itself present a solid, unbroken surface. Instead, it, of itself, presents the surface shown in Fig. 319. This fault is, however, in very great measure overcome by means of an image of the coils, which is reflected by a spherical mirror so placed (see Fig. 327) that it not only reflects, but also focuses an image of the coils between the coils themselves, as per Fig. 320. The image of the coils should be made the same size as the coils themselves, so that the image completely fills the space between the coils, and overlaps on the coils very slightly. This for all practical purposes presents to the collector a solid, unbroken light source, and while it is true that the image of the coils is, both in theory and fact, somewhat less brilliant than the coils themselves, still the difference is so slight that it is, to all intents and purposes, non-existent.

SHORT CIRCUITING IN COILS. — Reverting, let us again examine Fig. 318, which shows a very bad case of filament distortion. It is an abnormal case, only shown to illustrate what Mazda engineers had to contend with in evolving a support for the lamp filament which would prevent this trouble. Such a case will probably never be found in the modern lamp. The dark spots in the filament, Fig. 318, indicate short circuited turns of the coils, or, in other words, places where adjoining spirals of the coil touch each other, so that

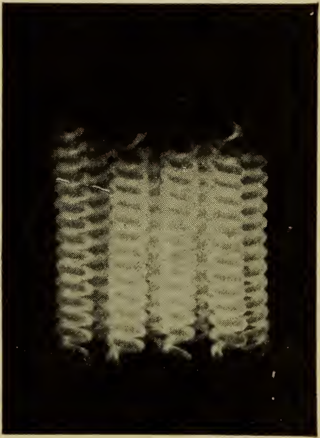


Figure 320.

the current jumps across, instead of traveling around the spiral. This fault also is extremely unlikely to occur in the later type lamp, but it does sometimes happen, and a dark spot in a coil is evidence of such short-circuiting.

It is, or should be, needless to tell you that in case a lamp filament does warp, distort or sag to any considerable extent the lamp should immediately be discarded, if for no other reason than because you can no longer focus the image of the coils entirely between the coils, which fault will result in a "streaky" screen.

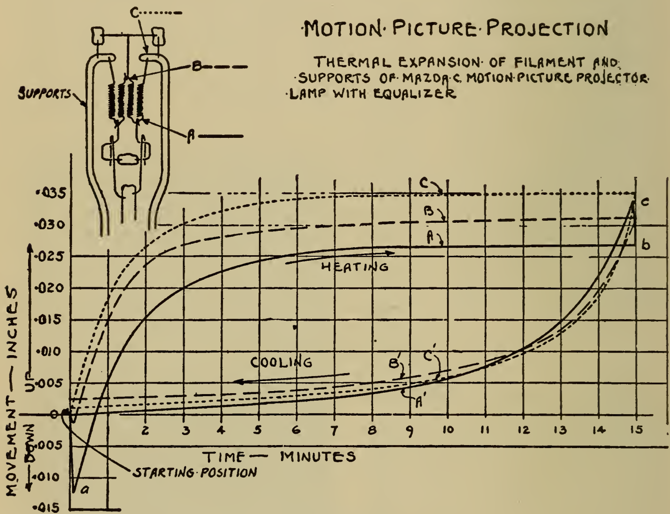


Figure 321.

In Fig. 321 we have a chart provided by the G. E. Company, designed to show the action of the filament under expansion and contraction. The cold filament has low resistance, therefore when the current is turned on it heats up almost instantaneously. This is graphically illustrated by curves in Fig. 321, in which the curve lines show the thermal expansion of the standard commercial filament, as now constructed.

As you may see by examining Fig. 317, the filament is suspended from above. Further examination of Fig. 317 will show you that when heat is applied, any elongation of the filament, as a whole, must and will be downward, because the construction of its support is such that the coils are left free to expand downward, whereas the support from above is rigid. Not all the lower part of the support is shown in Fig. 317, but it is shown very clearly in the drawing in Fig. 321. It consists of two long hooks which engage a wide loop in such way that the loop may slide up and down in the hooks.

In Fig. 321 the horizontal row of figures represents time in minutes, and the vertical row represents expansion of the coils in fractions of an inch. The upper curve lines represent expansion while filament is heating, and the lower lines contraction while the filament is cooling off. It is read thus. Suppose we draw a line straight up from 2 minutes in the horizontal row of figures, until it strikes the upper solid black line, and from there draw a horizontal line over to the vertical row of figures. We shall find it to strike the figure .015, therefore, since the solid black line represents the movement of the lower end of the filament under the influence of expansion, we see that at the end of two minutes after turning current on the cold filament, the lower end of the filament has moved .015 of an inch. The action of other points are read in the same way. You will observe that the total expansion and contraction reaches the surprising distance of almost .035 of an inch, but that this is not altogether in the filament itself, the actual filament expansion being represented in the difference between lines A (solid black) and B, (broken line), the rest being in the supports.

In reading the scale, the dotted line, the broken line and the solid line represent respectively the expansion and contraction of the top of the supports, the top of the filament and the bottom of the filament.

BLACKENING OF THE BULB.—As the age of a Mazda lamp increases, a deposit will form on the interior of the globe, which gradually causes a blackening of the glass. This is caused by what might be termed evaporation of the tungsten filament. The principle reason for making the Mazda projector lamp globe tall is to provide room above the filament, as it has been found that this deposit will invariably be made on the upper part of the globe, hence

With a tall globe the blackening of the glass is almost entirely above the plane of the filament. The blackening

which may occur at the plane of the filament is of such comparatively slight amount that it does not decrease the screen illumination from the lamp greatly, if at all.

The reason we say "if at all" is that, since the Mazda projector lamp is operated at constant current (amperage) instead of constant voltage, as is the case with the ordinary incandescent lamp, as the diameter of the filament is decreased by use, the lamp works at higher efficiency, hence gives off a sufficiently higher illumination to either entirely compensate for any blackening, or even more than compensate for it.

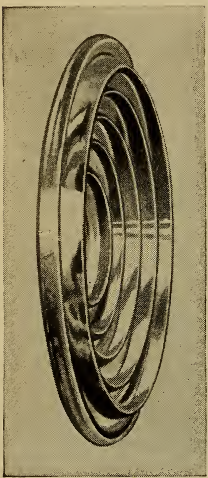


Figure 322.

The General Electric Company claims that, by actual tests during the life of a lamp, the total light flux of the lamp is increased by from two to five per cent., always provided the filament itself remain in otherwise perfect condition—does not warp, distort or sag. If the filament be warped, then while the total light-giving power may not be affected, still the light delivered to the screen will inevitably be decreased because of the impossibility of focusing the filament images between the coils, and thus securing an even, unbroken light source.

A Mazda motion picture projector lamp should seldom be discarded because of blackening of the bulb. Usually the only reason justifying the discarding of a lamp which is still in working order is the bad warping, sagging or distortion of the filament, or other fault in the filament itself, such as short circuiting of some portion of the individual coils.

QUALITY OF LIGHT.—There is a very decided difference in the tone of the light from the electric arc crater and from the Mazda lamp. Light from the electric crater is a clear, more or less bluish white, somewhat harsh and very brilliant light. Light from a Mazda lamp has, by comparison, a very much more mellow tone. To the ordinary eye it is, by contrast, a yellowish white. This operates in two ways. The light from the arc is, by reason of its bluish whiteness, very penetrating. The bluish whiteness of the light has the effect, especially at high amperage, of causing the white in the screen image to appear more or less chalky and unnatural. This the light from the Mazda lamp does not do. It gives to the screen image a more natural appearance, and the more mellow tone of the light is more restful to the eye. This is, however, qualified by the fact that if the screen illumination be of too low intensity there may be eye-strain induced through difficulty in discerning detail in the image.

Figure 323.

In Fig. 323 we may see the reason for using a large diameter projection lens. A laboratory Mazda lamp set up is shown, using a prismatic condenser, such as we see in Fig. 322. The prismatic condenser compels a very short distance between condenser and aperture, with a correspondingly wide divergence of the light beam on the projection lens side of the projector aperture, as shown. The possibility for loss of light through this condition and a small diameter projection lens may be understood by examining Figs. 46 to 57, pages 181 to 193.

In Fig. 324 we have the same identical set-up as in Fig. 323, except that whereas a small diameter projection lens is used in Fig. 323, a lens of large diameter is substituted in Fig. 324, which eliminates nearly all the light loss because the wider diameter enables the lens to pick up nearly the entire beam. The print (Fig. 324) shows no light loss at all, but the original photograph shows that even the large diameter lens fails to cover the entire beam, so that there is still quite a bit of loss.

In Figs. 325 and 326 we have the same identical set-up, insofar as concerns distance of projection lens, but instead of the prismatic condenser there is the regulation 2-lens plano convex combination ordinarily employed where an arc light source is used. This, you will observe, because of the

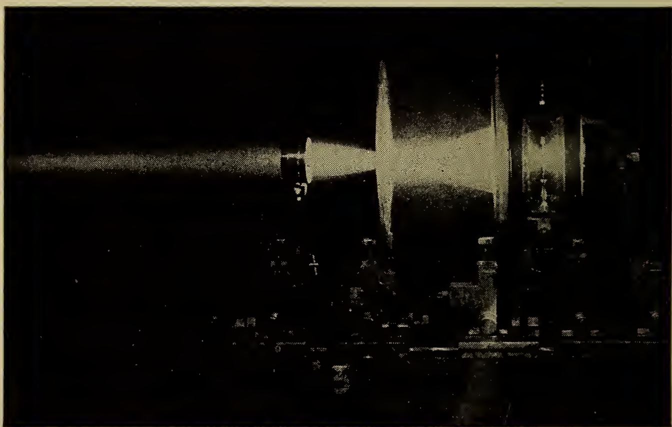


Figure 324.

greater distance from condenser to aperture, enables the smaller projection lens to pick up nearly all the light.

Again the print shows no loss, Fig. 325, but the original photograph did show some loss. The larger lens, Fig. 326, covers the entire beam. On the other hand, however, there is loss of light between the two condenser lenses and an additional reflection and absorption loss of about 12 per cent. in the added lens; also the light source is located a decidedly greater distance from the face of the collector lens than it is in the case of the prismatic lens. Exactly what the possibilities in light loss and other things as between the two systems may be we are unable to say. The thing is altogether too complicated, and we could not undertake to advise you on that point. It is to be observed, however, that there are a great many more installations of prismatic than of plano convex, which may or may not indicate superiority for the prismatic.

RELATIVE LIGHT TRANSMITTING POWERS.—Tests made by the engineering department of the General Electric Company as to the light transmitting power of small and large diameter projection lenses, commercially known as No. 1 and No. 2 lenses, show that, working without a projector revolving shutter the large diameter lens transmits double the light flux transmitted by the small diameter lens. This, however, only holds good where distance between con-

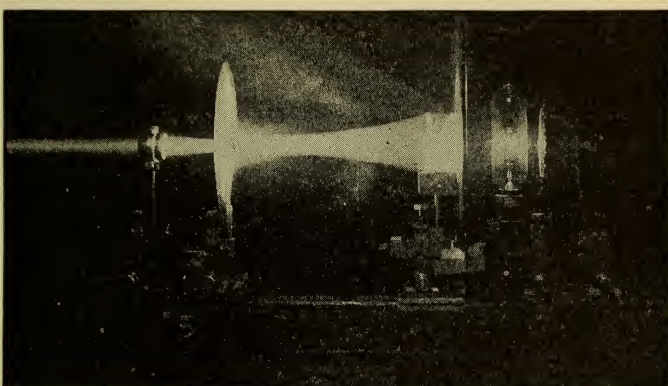


Figure 325.

denser and aperture is short, as where the prismatic condenser is used. Both the prismatic and plano convex systems have advocates, and both have advantages and disadvantages. We do not care to take sides. The thing has too many complications. Examine the merits and demerits of the two systems for yourself. It is one matter on which we do not, at least as yet, care to offer advice.

Remember this, however, if a prismatic condenser be used on a combination projector (M. P. projector with stereo attachment), it will be necessary to have a separate set of plano convex condensers for the stereopticon, which same may, however, be used for motion picture projection at any time, if it is so desired.

CONTROL APPARATUS.—The Mazda motion picture projector lamp filament must, in order to secure maximum screen illumination, be operated constantly at the full labeled capacity of the lamp. The instant the amperage drops below the labeled capacity of the lamp the screen illumination is decreased, and the decrease is very rapid. At 28 amperes, for instance, the screen illumination from a 30 ampere lamp drops to about 73 per cent. normal, and at 33 amperes it rises to about 160 per cent.

From this the projectionist can see the vital importance of operating the lamp constantly at its maximum labeled amperage of 30, carefully remembering, however, that while it is possible to operate it beyond its labeled capacity, and thus

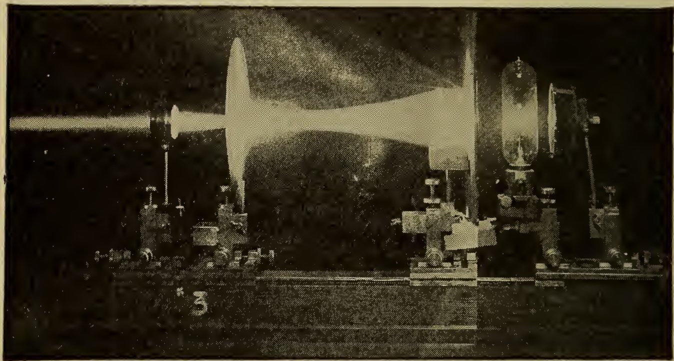


Figure 326.

secure a very much higher screen illumination, it will very greatly shorten the life of the lamp.

The amperage at the lamp should be under the control of the projectionist. Where the supply is A. C. this is accomplished by means of a specially constructed transformer, known as the "Regulator." These devices are made both automatic and for hand control. The automatic is opposed by many, on the ground that when the current is first turned on there is an instantaneous and rather heavy surge of current, which for the fraction of a second very heavily overloads the lamp filament. Further objection to the automatic is that when it is employed the projectionist has no control at all over the light producing power of the lamp.

With the hand controlled regulator the amperage at the lamp is entirely within the control of the projectionist. We recommend to you the hand regulator as best, except in cases where the current supply is subject to very heavy and constant fluctuations in voltage.

Another advantage of the hand controlled regulator is that whereas with the automatic regulator the filament of the lamp is heated up at full load immediately, with the hand regulator it may be, should be, and by the careful projectionist is brought up to maximum operating temperature gradually. The same reasoning applies to cooling the filament when shutting off the lamp. Still another advantage

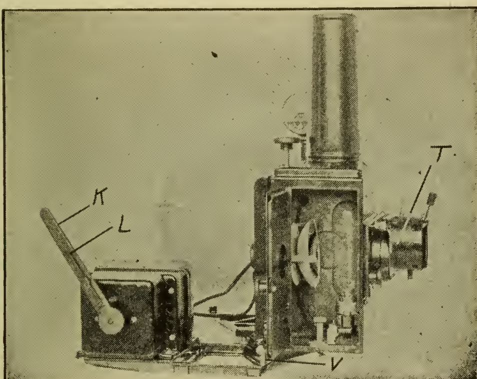


Figure 327.

of the hand regulator is that it is small, compact and may be mounted on the projector, where it should be, whereas in general the automatic regulator is bulky, and not so well adapted for mounting on the projector.

One of the most essential features in successful motion picture projection is the combining of regulator, lamphouse and ammeter into a single unit, placed on the projector, where it is right under the eye and hand of the projectionist.

GENERAL ELECTRIC COMPANY REGULATORS.—The General Electric Company manufactures three forms of hand controlled regulators for Mazda lamps operating direct from A. C. lines. Each of these devices is mounted on the same base as the projector Mazda lamphouse.

The type HDS Form E, Figs. 327, 328, 329 and 329½, hand controlled regulator is a straight transformer, wound and especially made for the regulation of amperage for the 30 ampere, 900 watt Mazda C motion picture projector lamp, for supply voltages from 75 to 250 and frequencies from 25 to 60. This type regulator has, according to manufacturer's claim, an efficiency of 90 per cent.

To Operate the regulator move lever K, Figs, 327, 328 and 329 toward the lamphouse (clockwise) until pin M, Figs. 328 and 329, strikes stop N, Fig. 328. With lever K in this position contact fingers H, Fig. 329, is on warming contact F, Figs. 329 and 329½, which connects with coil D, Figs. 329 and 329½, through which the current must pass. Coil D is the warming reactance, or choke coil. It acts to prevent a sudden rush of current through the lamp filament at the start, supplying, as it does, only sufficient current to bring the filament to a glow.

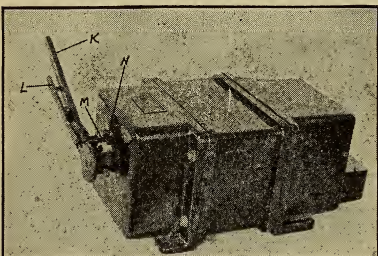


Figure 328.

If auxiliary lever L, Figs. 327, 328 and 329, be now shoved in, thus releasing stop pin M, and lever K be shoved further over toward the lamphouse, contact fingers H-H, Fig. 329 will successfully make contact with point G-G-G-G-G, Fig. 329, which has the effect of allowing more current to reach the lamp.

Contact reactance C, Figs. 329 and 329½, acts to prevent a momentary drop in illumination as the contact fingers move from one point to the next.

To Shut off Current it is only necessary to move lever L backward, away from the lamphouse. This opens the circuit on the primary side of the transformer.

In Fig. 329, A indicates the line leads and B the lamp leads. In other words you connect from contacts A to the line, and from contacts B to the lamp.

Type HMC, Form B, hand controlled regulator, illustrated in Figs. 330, 331 and 332, varies the amount of current supply to the lamp filament by magnetic action. It is made for use with the 30 ampere, 900 watt Mazda motion picture projector lamp, and is designed for use on voltage from 100 to 125 and 200 to 250 and on frequencies from 25 to 60.

To Operate move the control lever L, Figs. 330 and 331, towards lamphouse until click of switch F, Figs. 331 and 332, is heard. Armature E, Fig. 331, then shunts the magnetic flux from secondary coil D, Figs. 331 and 332, so that only a small amount of current passes through the lamp filament. As lever L is moved further toward the lamphouse, armature E, Fig. 331, attached to lever L, and therefore rotating with

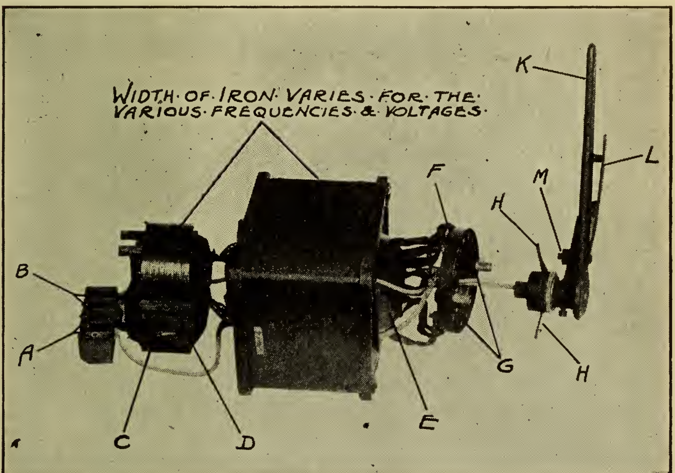


Figure 329.

it, increases the air gap and decreases the amount of shunted flux through it, the effect of this being to increase the current flow through the lamp filament.

To shut off the current it is only necessary to move lever L away from the lamphouse, which rotates armature E until it trips pin G, Figs. 331 and 332, thus opening switch F, Figs. 331 and 332, which will cause a clicking sound.

In Figs. 331 and 332, A denotes location of line, and B of lamp leads.

Type HMC, Form A, hand controlled regulator, illustrated in Figs, 333, 334 and 335, varies the current strength magnetically, and is designed for use with the 20 ampere, 600 watt lamp.

To Operate, turn on snap switch H, Figs. 333, 334 and 335, making sure that pointer on knob L, Figs. 333 and 334, is at the "low" position. Armature D, Fig. 334, will then be inside coil C, Figs. 334 and 335, and in this position it shunts the magnetic flux. As knob L, Figs. 333 and 334, is turned in a counter clockwise (to the left) direction, armature D is withdrawn from coil C, Figs. 334 and 335, which causes it to shunt

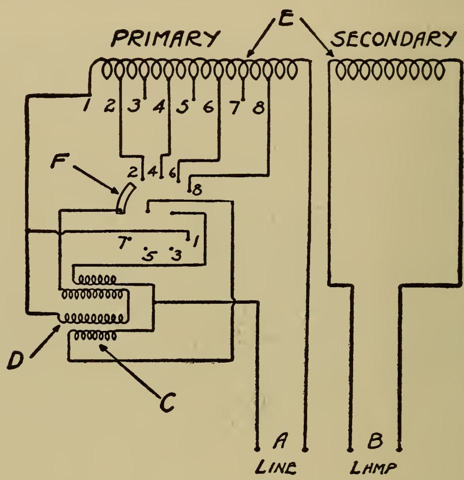


DIAGRAM OF CONNECTIONS · TYPE · H·D·S· FORM·F GENERAL·ELECTRIC COMPANY· CURRENT·REGULATOR

Figure 329½.

less flux, which has the effect of increasing current flow through secondary coil G, Figs. 334 and 335. In Fig. 334, E is an auto-transformer, F being the primary and G the secondary winding. A-A are the line and B-B the lamp leads.

To Shut off Current, turn knob L, Fig. 333, clockwise (to the right) to "Low" point and then open the switch.

AUTOMATIC REGULATOR.—The General Electric Co. also makes an automatic regulator called the Constant Current Regulator, Type RM. This is illustrated in Fig. 336 and its windings in 337. It is for use with the 30 ampere, 900 watt lamp, and has a regulation of 1 per cent., with (manufacturer's statement) an efficiency of 85 to 95 per cent.

To Operate, separate the two coils of the auto-transformer, Figs. 336 and 337. Then throw in the line switch, after which let the two coils come together gradually until the moving coil floats freely. To turn off the current, separate the coils, pull switch and then move coils together again. The balancing weight has ball bearings, to insure freedom of movement.

SYNCHRONOUS CONVERTER—To take care of the D. C. situation the General Electric Company puts out the "synchronous converter," shown in Fig. 338. The motor re-

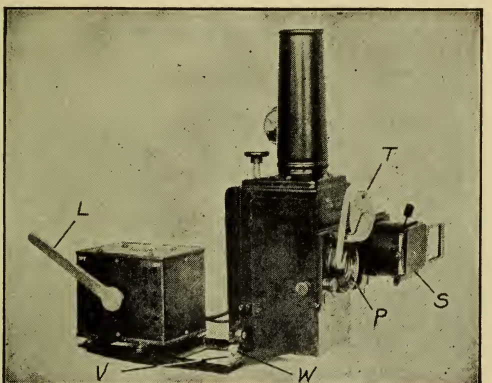


Figure 330.

ceives D. C. from the lines and delivers A. C. at about 25 cycles to the lamp. This seems peculiar, because whereas in arc lamp projection we go to heavy expense to convert A. C. into D. C., in Mazda the reverse is true, and for best results we convert D. C. back into A. C.

The synchronous converter has sufficient capacity to take care of the Mazda light source for two projectors. It is nothing more or less than a small synchronous converter connected up opposite to the way the synchronous converter is usually hooked up. It delivers A. C. at about 78 volts. It is about two feet in length, stands about one foot high and weighs something like 75 pounds. Its general care is covered under general instructions on motor generators, see Pages 444 to 461.

REGULATOR NECESSARY.—Let it be clearly understood that a regulator is necessary where a synchronous converter is used, but in this case a special regulator will be required, because the converter delivers current at lower voltage than the voltage of power lines.

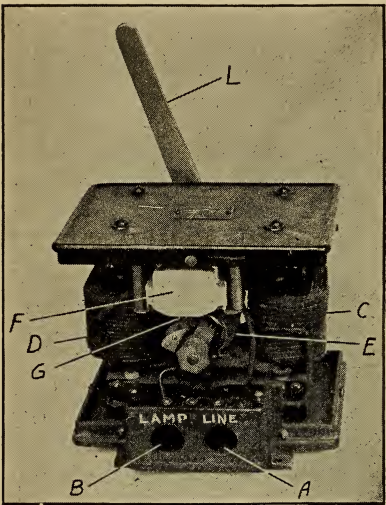


Figure 331.

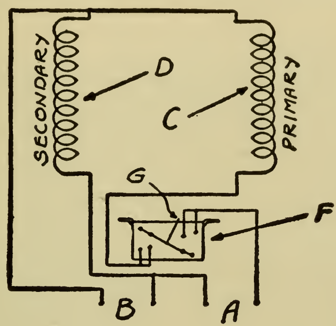
RHEOSTATIC CONTROL.—In general, D. C. Mazda lamp installations using rheostatic resistance are not recommended. True, many of these installations have been made, and have given satisfaction to the exhibitor. They are not, however, recommended by lamp manufacturers, nor do we recommend them. The manufacturer will make such an installation if it is demanded, but for many reasons they recommend the synchronous converter, which, aside from first cost of installation, is much more efficient in operation than is rheostatic control.

HALLBERG REGULATOR.—J. H. Hallberg manufactures an automatic regulator for A. C. Mazda projector lamp installations, called the "Hallberg A. C. 4 in 1 Mazda Lamp Regulator." It is illustrated in Fig. 339. This regulator is constructed upon the constant current transformer principle. The secondary coil is stationary, while the primary coil is movable on a vertical central core This coil is supported so as to be adjusted to the correct position on the core for each particular lamp, and any change in current strength over that for which the transformer is set causes the primary coil to automatically alter its distance from the secondary coil. It will therefore be seen that current changes at the lamp filament will of necessity be very small.

The device is supplied with an ammeter, and there is a conveniently located arrangement for adjusting the coils, or "setting" the coils for any desired current value within range of the apparatus.

The Hallberg 4 in 1 is well made, and a good instrument of its kind.

USING THE LAMP SETTER.—For the purpose of mounting the Mazda projector lamp in socket the General Electric Company puts out what is known as a "lamp setter," illus-



DIAGRAM·OF·CONNECTIONS·TYPE·H·M·C FORM·B·GENERAL·ELECTRIC·COMPANY ·CURRENT·REGULATOR·

Figure 332.

trated in Fig. 340. By the use of this setter it is possible to mount the lamp in its socket in such a way that an old lamp may be pulled out of the lamphouse and a new one installed, with every assurance that the filament of the new lamp will occupy precisely the same place with relation to the optical axis and the lens as did the old one; also the filament will be square with the face of the collector lens. To use the lamp setter, proceed as follows

(A) Unscrew large nickel-head screw A, Figs. 340 and 341, until it is backed out ⅜ to 7/16 of an inch.

(B) Loosen small clamp screws B-B, Figs 340 and 341, on lamp socket.

(C) Unscrew center contact C, Fig. 341, until it is flush with bottom of socket base.

(D) Insert lamp in socket, being sure to push it all the way down, at the same time making sure that the upper half of socket D-D, Figs. 340 and 341, moves freely in all directions, and that the lamp does not bind.

(E) Unscrew two large knurled screws, E-E, Fig. 340, E, Fig. 342, and E, Fig. 343, and open gate F as shown in Fig. 340.

(F) Insert socket, with lamp in place therein, in lamp setter, and close gate F, Fig. 340.

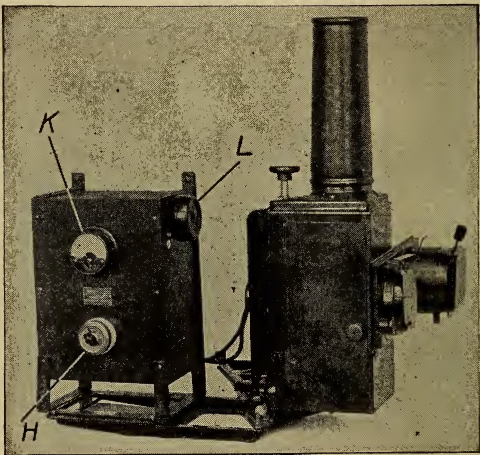


Figure 333.

(G) Turn lamp in its socket until edges of filament are parallel with notch G, Fig. 342, and with the notch on opposite side of setter.

(H) Look through sight holes H-H, Fig. 343, and raise lamp in center by screwing up on center contact from the bottom, as per Fig. 344, until bottom of filament coils is flush with lower edge of sight holes, as per Fig. 343.

(I) According to which is necessary, tighten or loosen knurled adjusting screws E, Fig. 343, until the point of the two pins in bottom of sight holes come exactly between the two center coils of the filament when you sight through the sight holes.

(J) Should the filament not now be vertical, screw in or out, as the case may require, screw A, Figs. 340, 341 and 342, until filament is vertical, after which repeat operation I.

(K) Tighten or loosen knurled head screw E, Figs. 340 and 342, until the filament is in line with the two notches in gate, as per Fig. 342. This is the focusing adjustment. It locates the filament the correct distance from face of collector lens.

(L) Check vertical (height of lamp) lateral (location of pins between center coils of filament) and focusing (distance from lens position) adjustments and be sure you have them EXACTLY right.

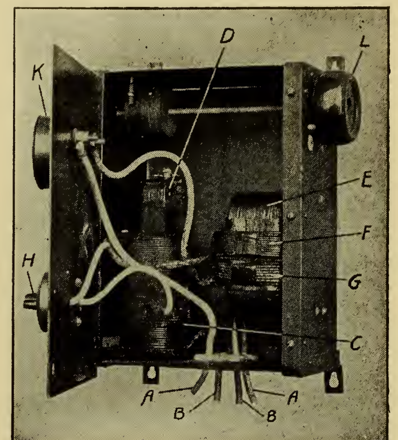


Figure 334.

(M) Tighten socket clamp D-D, Fig. 341, by screwing up socket clamp screws B-B, Figs. 340 and 341, as shown in Fig. 345, thus locking the lamp in place in its socket.

(N) Gently tighten up on center socket contact C, Fig. 341, as shown in Fig. 344, until it makes firm contact with base of lamp. This latter is important in order to secure good contact and prevent possible arc between lamp and socket. Be careful, however, and do not tighten the screw too tight, and thus force the lamp out of alignment in socket.

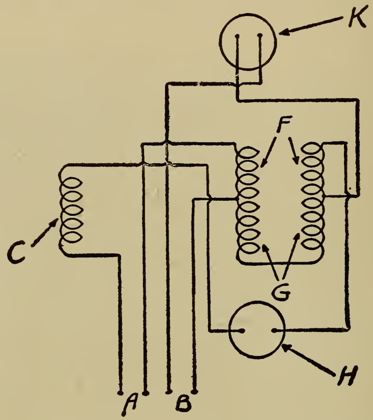
(O) Open gate F, Fig. 340, and unscrew knurled head screws E-E, Fig. 340, until they do not touch the lamp.

(P) Check lateral adjustment, and if found wrong, correct same by tightening or loosening nickel-head screw A, Figs. 340 and 341.

(Q) Lamp and socket may now be removed from lamp setter, and may be inserted in base K, Fig. 346, with full assurance that if the various steps in the process (which is not at all complicated, once you learn it) have been faithfully and correctly followed, the lamp will be exactly in correct position for projection without further adjustment.

ALIGNMENT.—TO SECURE MAXIMUM SCREEN ILLUMINATION, IT IS ABSOLUTELY NECESSARY THAT THE CENTER OF LAMP FILAMENT, CENTER OF APERTURE AND CENTER OF PROJECTION LENS BE EXACTLY ON THE OPTICAL AXIS OF THE SYSTEM.

CAUTION.—This is of very great importance with all Mazda projector lamp outfits because if any one of the elements named have its center even so much as 1/16 of



·DIAGRAM·OF·CONNECTIONS·TYPE·H·M·C·
·FORM·A·GENERAL·ELECTRIC·COMPANY·
·CURRENT·REGULATOR·

Figure 335.

an inch off the optical axis the screen illumination will be very greatly reduced.

To align the elements, first light the lamp and then open the dowser. Raise the automatic fire shutter or open the projector gate and turn projector fly-wheel until revolving shutter has opened the lens. Be sure lamphouse is all the way over against stop V, Figs. 327 and 330, in position for projecting motion pictures.

Move the whole carriage Q, Fig. 347, carrying the regulator and lamphouse forward until the front surface of the prismatic condenser is 6.5 inches from the aperture as per Fig

351, except where state laws require a greater distance. Have a piece of dark colored, low reflecting cardboard held in front of the projection lens, at a distance therefrom which will sharply focus the rings of the condensing lens. Loosen wing nuts Z-Z-Z-Z, Fig. 347 (four of them) and raise or lower the lamphouse until the same number of rings show, up and down, in the image on the cardboard, as per B, Fig. 348. In other words, the image of the condenser is exactly centered up and down. Tighten wing nuts Z-Z-Z-Z firmly when done.

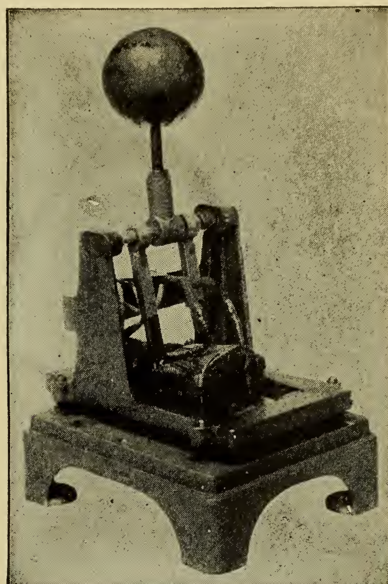


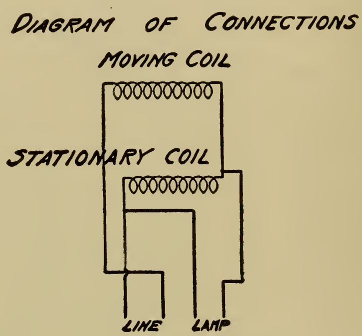
Figure 336.

Next move lamphouse sidewise on its tracks until the same number of rings show sidewise in the image on the cardboard, as per D, Fig. 348, first, however, making certain that condenser holder is shoved clear over against its stop S, Fig. 350. The lamphouse may then be moved sidewise by screwing or unscrewing the nickle-head screw W, Fig. 347. This screw must be against stop V when the job is done. Screw W must then be locked by set screw J, Fig. 347. This completes the centering of the condenser with the optical axis.

ADJUSTING FILAMENT OF LAMP ON OPTICAL AXIS.—It is of the very greatest importance imaginable that the center of the lamp filament be exactly on the optical axis of the optical train of the projector. Once a lamp has been adjusted in its socket in the lamp setter, as per instructions already given, and the filament has been centered on the optical axis, as per instructions we shall now give, all lamps thereafter adjusted **in the same lamp setter** will require no further adjustment, unless the adjustment become in some way altered, which should not happen in ordinary routine of work.

To center a lamp which has been previously properly adjusted in the lamp setter (always adjust lamp in lamp setter before you proceed with the following instructions, because if you did not, your work would all be for nothing), proceed as follows:

(A) Insert a lamp, previously adjusted in lamp setter as



GENERAL ELECTRIC CO. FORM RM
CONSTANT CURRENT REGULATOR FOR 30 AMP.
900 WATT MAZDA MOTION PICTURE LAMP

Figure 337.

per former instructions, in base K, Fig. 346, and shove it in as far as it will go.

(B) When focusing, or adjusting a lamp for the first time, loosen mirror clamping knob X, Fig. 347, and tip mirror either up or down by means of handle Y, Fig. 347.

(C) Place revolving shutter of projector from ½ to 1 inch from front end of projection lens barrel.

(D) See that primsatic condenser lens is in proper position for projection and pull lamphouse over against stop V, Fig. 347.

(E) Open dowser and either the automatic fire shutter or the projector mechanism gate.

(F) Light the lamp.

(G) Adjust projection lens so that edges of aperture are sharply focused on screen.

(H) Set revolving shutter in such position that light beam falls on one of its blades, as per Fig. 349. The filament image will not necessarily be sharp.

(I) Shove in or pull out the lamp socket by means of the small lateral adjustment screw L, on contact base K, Fig. 346, until the two center coils of the filament are exactly in center of lighted spot on shutter blade.

IMPORTANT.—Do not touch large nickeled screw A, Fig. 350, on lamp socket.

(J) Loosen socket base clamp T, Fig. 350, on steel plate carrying contact base, and move lamp forward and back until you get the smallest possible spot of light on aperture of projector, or until screen is brightest, though the screen will not at this stage of the proceedings be evenly illuminated. After this is done, tighten clamp screw T, Fig. 350. The distance of the filament from face of condenser will be found to be between 2⅛ and 2¼ inches, as per Fig. 350.

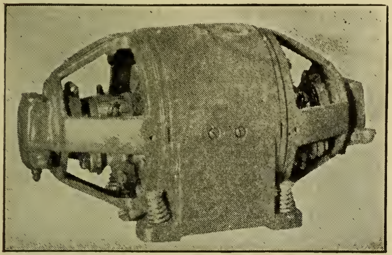


Figure 338.

(K) Test matter of filament being in center of spot on shutter blade. If too far to left screw in lateral adjustment screw L, Fig. 346, and shove lamp base further into its holder. If too far to right, reverse the procedure. If all directions have been faithfully followed the light should now be correctly centered on the projector aperture. If when filament image is in center of spot on shutter blade and spot at aperture of projector is out of center, then you have made some mistake and must do the whole job over again. But be certain the two center filament coil images are in center of spot on shutter. When lamp is properly set, lateral adjustment stop N, Fig. 350, above small screw K on contact base should firmly touch nickle screw A, Fig. 350, on lamp socket. Contact base is now properly set with respect to the lamp setter, and should require no further adjustment, but be sure the condenser slide and housing (these have to do with prismatic condensers only) are in correct position.

IMPORTANT.—The lamphouse, the condenser and the lamp setter are now adjusted with relation to each other, so that all lamps adjusted in the individual lamp setter used should be, and will be in correct position when placed in the lamphouse. One lamp setter is suffcient for a number of projectors. It should be clearly understood that **the same lamp setter must be used for a lamphouse all the time, or if another setter be used, then the lamphouse will have to be readjusted to center the filament of the new lamp on the optical axis.**

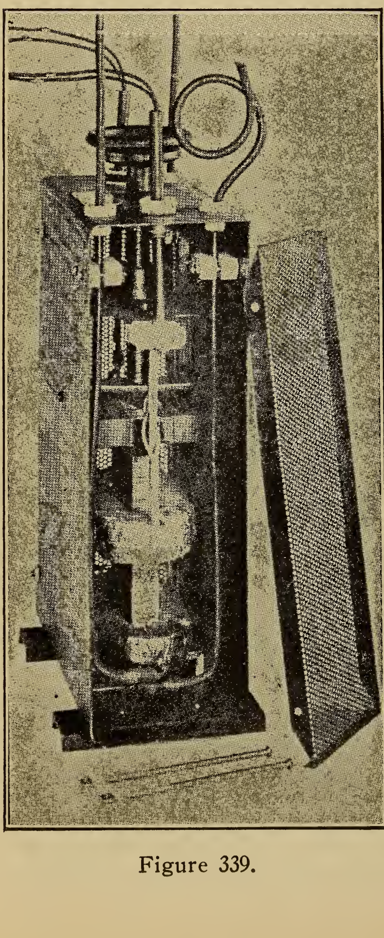


Figure 339.

(L) Close dowser T, Fig. 330, in the center of which is a pin hole, whereupon an image of the filament will be projected through the pin hole and will be clearly defined on the automatic fire shutter.

CAUTION.—The pin hole must not be used in focusing the condensing lens or aligning lamp filament. It is only designed to serve as a method of checking the placing of the mirror with reference to the filament.

The image projected through the pin hole will not necessarily be centered on the aperture, and the fact that it is off center with the aperture does not indicate that the line up of the condenser and lamp filament is incorrect. Next move the mirror by means of knob Y, Fig. 347. By turning the knob clockwise, the mirror image is made smaller and vice versa. This adjustment should be so made that the mirror image of the filament coils and the image of the filament coils are of exactly the same size. The mirror must now be so adjusted that the mirror image of the coils falls between the coils themselves, as per Fig. 320, whereupon the mirror must be

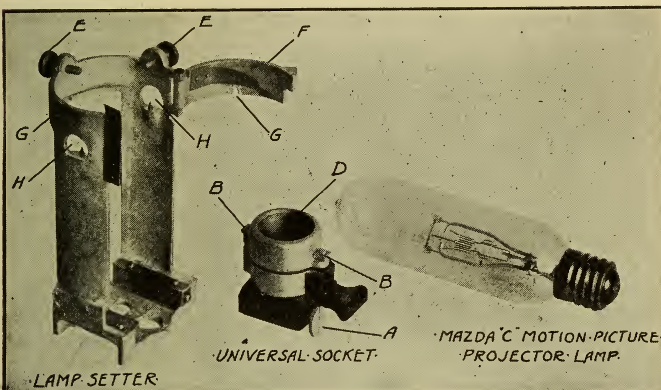


Figure 340.

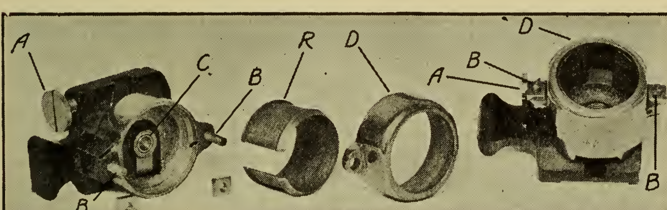


Figure 341.

locked rigidly in place by tightening knob, Fig. 347. Unless this adjustment be made right, the screen will be streaked vertically.

With the mirror correctly set, it should never be necessary to change it, though its adjustment should be checked from time to time to make sure that it is in correct position. This the projectionist may observe at any time by glancing at the automatic fire shutter when the dowser is closed. It may also be observed on the revolving shutter while the projector is in operation.

If when a new lamp is installed, the mirror images do not fall exactly between the filament images, move the mirror slightly one way or the other until the fault is remedied, but do not touch the lamp socket, or the adjusting contact screw N, Fig. 350.

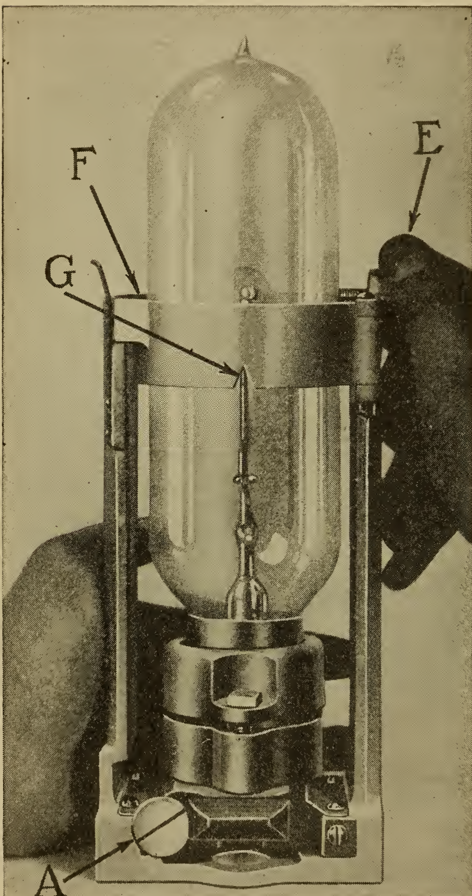


Figure 342.

IMPORTANT.—Never use anything except lever K and L, Fig. 347, to start up the lamp, or to turn it off. If you leave controller lever K at "on," and pull the projector table switch, you will put the lamp out all right, and you may put it out of business for good, too.

ADVANTAGES OF MAZDA LAMP PROJECTION.— The main advantage in Mazda lamp projection is economy of operation. We can illustrate this advantage by comparison. Let us assume it is proposed to install Mazda lamp projection in a theatre using 35 ampere D. C. arcs. This is not extreme because it is very generally conceded that the Mazda lamp can succesfully replace carbon arcs of much higher amperage. Let us assume that the voltage of the arc is 55, under which condition we would have 55 × 35 = 1,925 watts consumed in the arc itself. This does not, however, represent the total consumption of the installation, since the line voltage, which may be 110 or higher, must be reduced to the arc voltage, or in other words to about 55 volts. The most efficient method of doing this, and at the same time delivering the necessary amperage at the arc, is by means of a motor generator, and these ma-

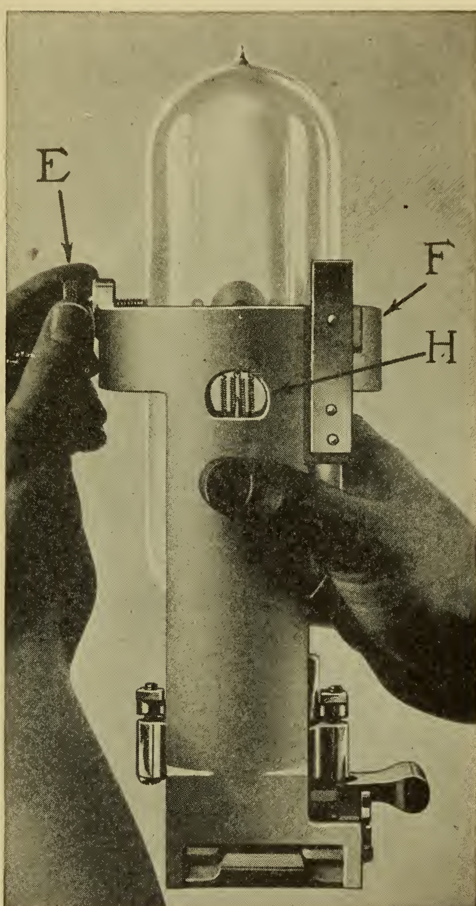


Figure 343.

chines cannot be expected to operate at greater than 70 per cent. efficiency. As a matter of fact, a motor generator set usually operates at decidedly less than this, particularly after they have been used for a while. It therefore follows that the 1,925 watts consumed by the arc represents but 70 per cent. of the total power consumed, which would be 2,751 watts. If ballast resistance be used, the inefficiency of the motor generator may be much lower than this.

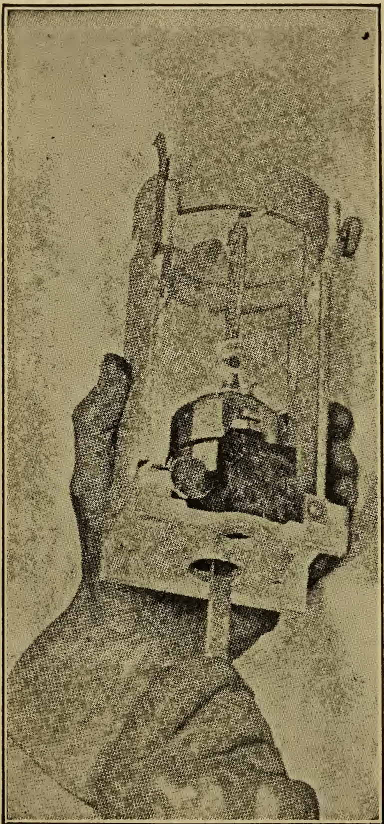


Figure 344.

On the other hand, the Mazda lamp equipment with which it is proposed to replace this installation would consist of a 900 watt T-20 bulb lamp, which operates at 30 amperes and approximately 28-32 volts, so that we must reduce the line voltage to this value. A specially constructed hand controlled regulator is made for this purpose, which operates at (manufacturers' claim) about 90 per cent. efficiency, hence the 900 watts consumed in the lamp represents 90 per cent. of the total power taken from the lines, that is, 1,000 watts.

The difference in wattage consumption would therefore be 1,750 watts in favor of the Mazda lamp, or more if the arc is supplied by a motor generator using ballast-resistance. We must, however, consider another item of cost, viz.: that of lamp renewal and carbon consumption. It is impossible to give accurate figures in these items, but it is safe to assume that the cost of necessary lamp renewals and of carbon consumption will be about equal. The saving through the use of Mazda equipment is, therefore, a matter of a difference in current consumption. Supposing the theatre to be open ten hours a day, the cost of current for operating the carbon arc per year, assuming power to cost .07 cents per kw., equals .07 × 10 (hours per day) × 365 (days per year) $\times \dfrac{2{,}750 \text{ watts consumed}}{1{,}000} =$ \$703. The cost of the Mazda on the other hand is .07 × 10 (hours per day) × 365 (days per year) $\times \dfrac{1{,}000 \text{ watts}}{1{,}000} =$ \$256, so that the actual saving would be the difference between \$703 and \$256, which is \$447 a year.

The relative cost of any Mazda lamp and arc installation operation may be calculated in the same way, merely by substituting the correct values, except that when the power lines supply direct current and A. C. is not available, it is then best to use a small synchronous converter (Fig. 338), which takes D. C. from the lines and delivers A. C. to the lamp. The cost of operation of this form of installation is somewhat higher than straight A. C., because of the higher cost of the converter, but it is much cheaper than taking D. C. through resistance.

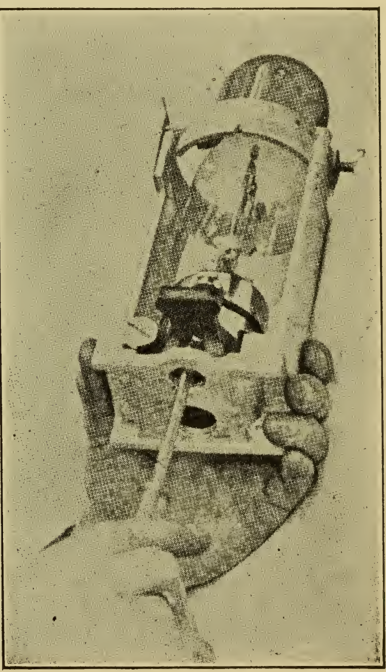


Figure 345.

It therefore resolves itself into a problem, in so far as finances go, as to whether the screen results will be such that the drawing power of the theatre will not be materially decreased, because it would require but a slight loss in drawing power at the box office to amount to the sum saved in current.

There are, however, several other advantages in Mazda lamp equipment. For instance, with Mazda lamps there is nothing like as much heat dissipated in the projection room, therefore the work of the projectionist is made very much more comfortable. Also with Mazda lamps the light source is absolutely steady, and once it is properly adjusted and set going it requires no attention whatever throughout the run, unless the supply voltage fluctuates heavily. With the carbon arc installation there is a certain amount of carbon dust set free in the air, which besides setting up a more or less unhealthy condition for the projectionist, gets into the

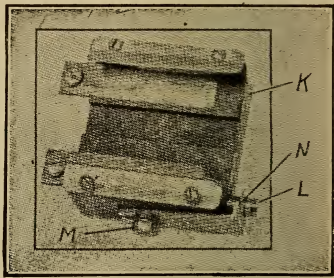


Figure 346.

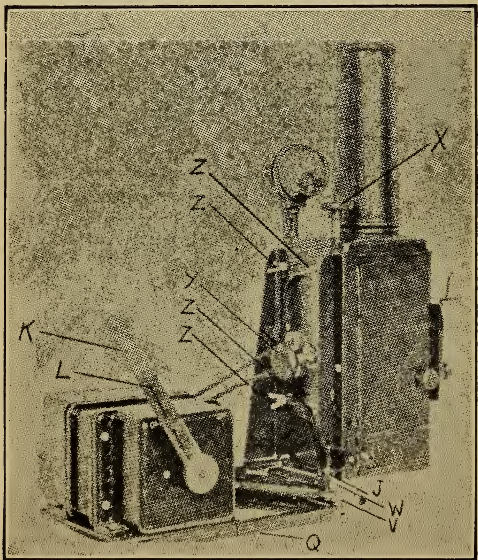


Figure 347.

bearings of a projector and causes considerable wear. Then, too, there is the white ash which is the product of the volatilization of the carbon cores, and there is more or less carbon monoxide gas which is not especially healthful,

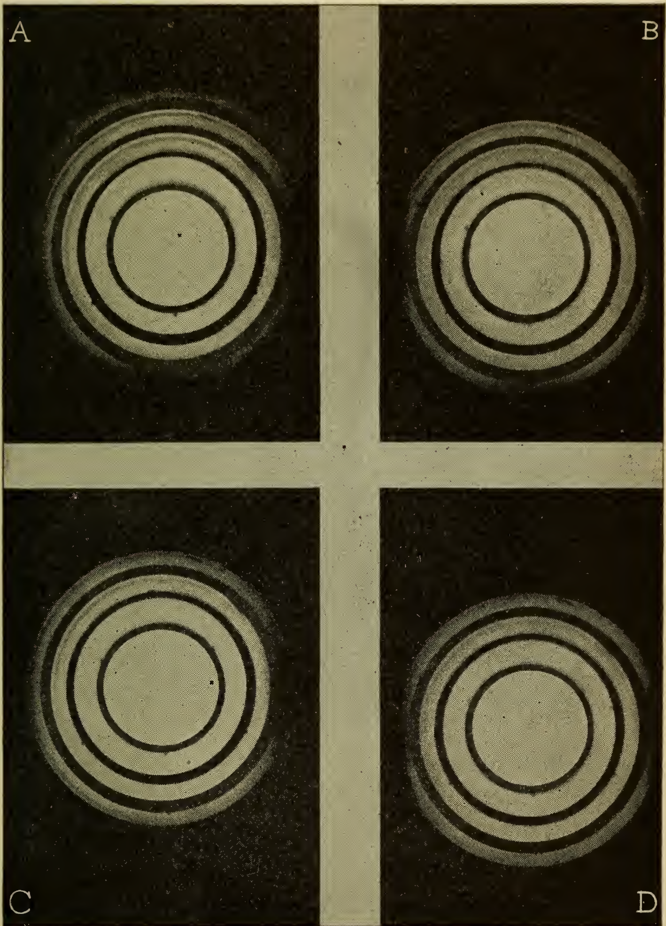


Figure 348.

though as a matter of fact most of it is nowadays carried outside of the projection room. Everything considered, it cannot be denied that the Mazda light source is more healthful and comfortable to work with than is the arc light.

NOT SIMPLE.—Many projectionists have objected to Mazda lamp projection because they believed it would not

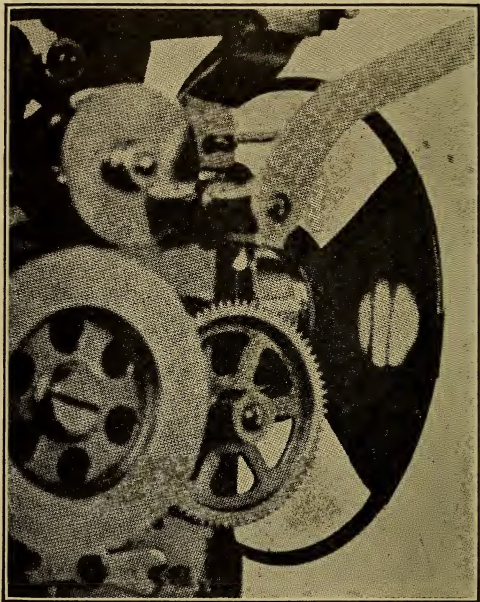


Figure 349.

require much skill to handle, therefore it could be handled by a man of little experience or knowledge. This is a mistaken idea. While it is true that once adjusted the Mazda lamp is rather simple and easy to manipulate, still its adjustment is a very much finer operation than is the adjustment of the carbon arc. It takes real brains and intelligence to get the best possible results out of a Mazda Motion Picture Projector Lamp since it is essential that every possible bit of illumination be got through to the screen.

Another distinct advantage is that with Mazda lamp projection the projectionist really has nothing to do but watch his screen and attend to the projection of the picture, which, after all, is the important thing.

The advantages claimed for Mazda lamp projection may be summed up in the following:

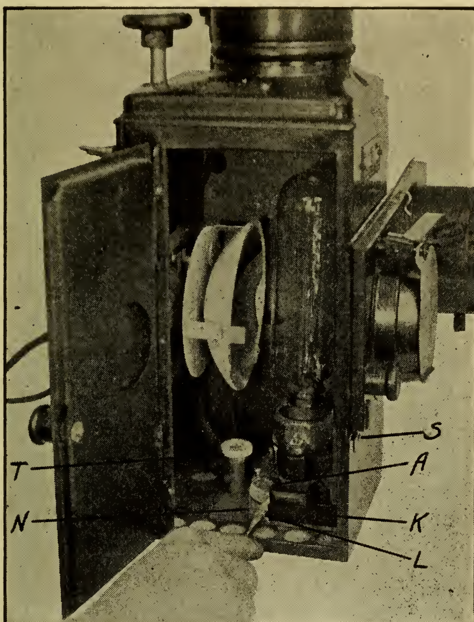
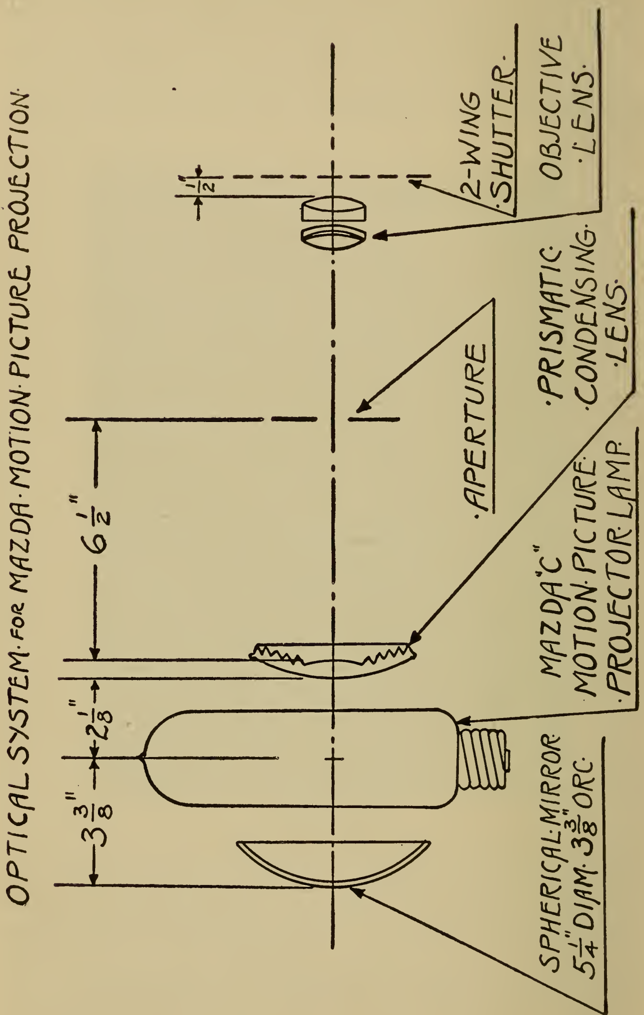


Figure 350.

1. Economy of operation.	Reduction of current bills from 30 to 60 per cent.
2. Steady light.	No variation in light intensity.
3. Soft, pleasing light.	No harsh blue light.
4. Easy of operation.	Lamp once set needs no further attention until removal.



OPTICAL SYSTEM· FOR MAZDA· MOTION· PICTURE PROJECTION·
3 3/8"
2 1/8"
6 1/2"
1/2
2-WING ·SHUTTER·
OBJECTIVE ·LENS·
·APERTURE
·PRISMATIC ·CONDENSING· ·LENS·
MAZDA "C" MOTION· PICTURE· ·PROJECTOR· LAMP·
SPHERICAL·MIRROR· 5 1/4" DIAM· 3 3/8" ORC·

Figure 351.

5. Prevents excessive heat in projection room.	Wattage dissipated in heat much lower than that of arc.
6. Healthful operating conditions.	No carbon dust or fumes for projectionist to inhale.
7. Longer life of projector parts.	No carbon dust to wear bearings.

Fig. 351 is a graphic illustration of the Mazda lamp line up, the distances therein are all a fixed quantity when using prismatic condensers.

The following is a tabulation of the possible causes and remedies of unsatisfactory screen illumination:

Trouble.	Remedy.
1. Lamps operated under amperage.	Operate at rated amperage.
2. Optical system out of alignment.	See Method of Proper Alignment of Optical System.
3. Lamp burned beyond its useful life.	New lamp.
4. Dirty mirror and lenses.	Clean mirror and condenser thoroughly every day. See "Cleaning Lenses," Page 137.
5. Number one or quarter size projection lenses, 1¾ inch diameter.	Use number two or half size lenses 2½ inch diameter whenever possible, i. e., where focal length is 5 inches or greater.
6. Incorrect distances between parts of optical system.	See method for proper alignment of optical system.
7. Three-wing shutter.	Use a two-wing shutter.
8. Wrong type of screen.	Use screen suitable to the requirements of theatre.

The following is a tabulation of the probable causes and remedies of low average life of lamps:

1. Ammeter out of adjustment.	Correct by checking with standard ammeter.
2. Improper method of lighting lamps.	Always use handle on regulator to avoid initial surge of current.

The following is a tabulation of the probable causes and remedies of uneven screen illumination;

1. Incorrect setting of mirror.	Correct setting. See method for proper alignment ot optical system.
2. Lamp filament badly warped out of parallel, or a small section short circuited.	New lamp.
3. Condenser lens out of alignment.	See method for proper alignment of optical system.

BAUSCH & LOMB CINEPHOR CONDENSER

The following instructions for aligning the Bausch and Lomb Cinephor condenser for motion picture projection in conjunction with the General Electric incandescent lamp equipment were prepared for this book by the engineering department of the Edison Lamp Works of the General Electric Works at Harrison, N. J. They may therefore be relied upon as authoritative.

IN GENERAL.—The Bausch and Lomb Cinephor condenser is now standard equipment for the General Electric incandescent lamp equipment for motion picture projection. So true is this that if a Prismatic condenser is desired it must be so specified when ordering.

In figure 352 we have a dissembled view of the Bausch & Lomb Cinephor condensing lenses, and their mount, as used in the G. E. incandescent equipment for motion picture projection. The lenses and mount are shipped completely assembled, however, as viewed in figures 353 and 354. The condenser mount is attached to the lamphouse in the same manner as is the prismatic condenser mount, with which most motion picture projectionists are familiar.

OPTICAL ALIGNMENT.—In order that the maximum screen illumination be secured, it is essential that the lamp filament, the projector aperture, the condenser and the projection lens all be centered EXACTLY upon the optical axis of the optical train of the projector. **WARNING:** IF ANY OF THESE ELEMENTS BE OFF CENTER BY EVEN SO LITTLE AS ONE SIXTEENTH OF AN INCH, THE SCREEN ILLUMINATION WILL BE GREATLY REDUCED.

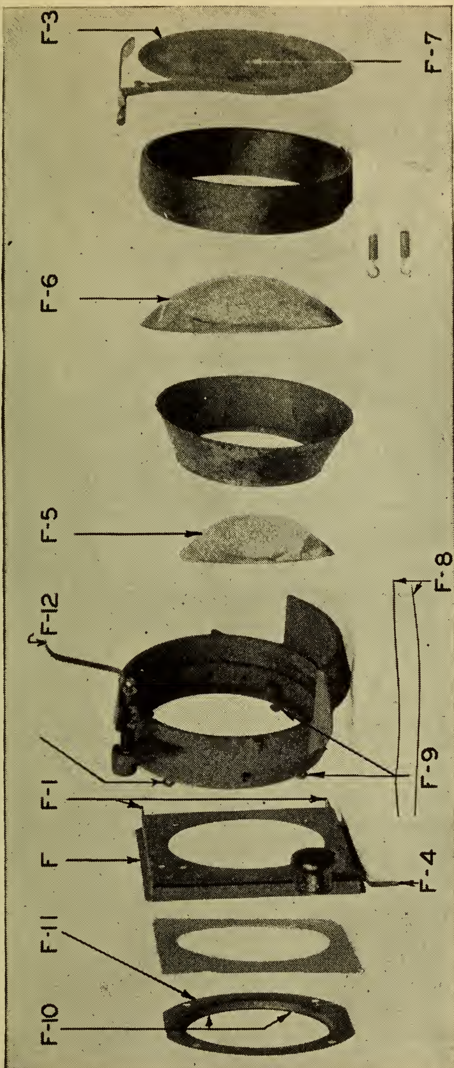


Figure 352

Unlike the prismatic condenser, the aspheric, or parabolic (Cinephor) condenser has a pinhole in its dowser, F7, figure 354 which is accurately centered with relation to the lens elements, so that when the condenser, as a whole, is properly aligned with the projector aperture and projection lens, the dowser pinhole will be exactly on the optical axis of the optical train.

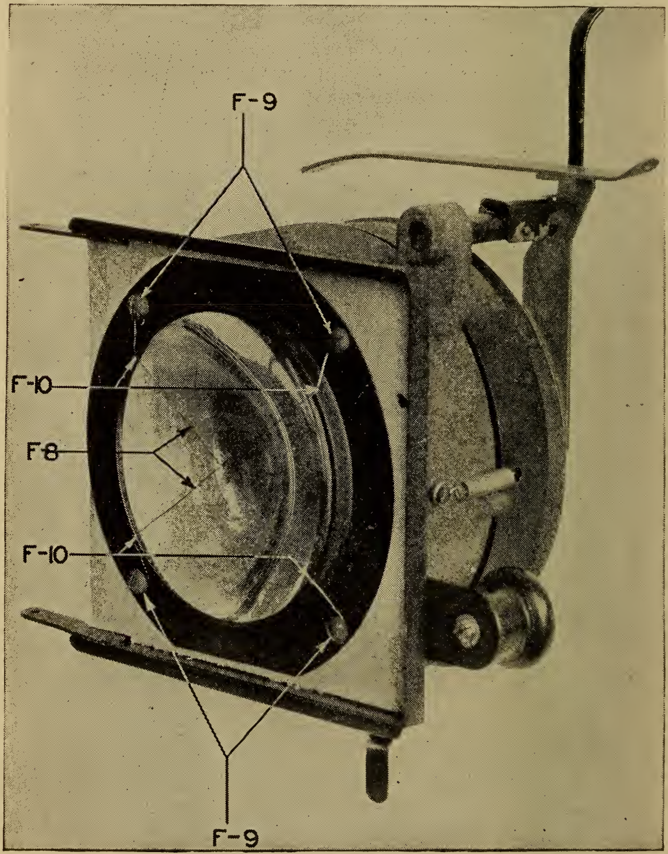


Figure 353

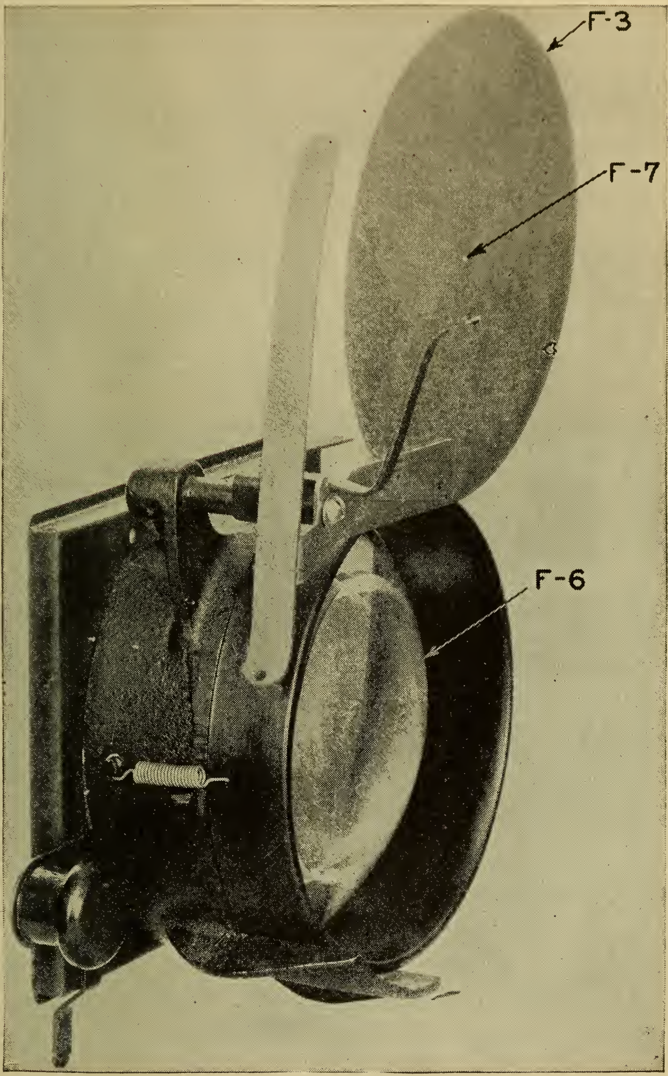


Figure 354

Across the outside surface of the collector lens—lens next to light source—two crossed wires are stretched, F 8, figure 353. The intersection of these wires falls exactly in the center of the condenser. With this fact in mind, we have two known points on the condenser which exactly mark its center, Viz: the intersection of the wires and the dowser pinhole. These two points are of great assistance in the work of aligning the condenser with the aperture and projection lens.

ALIGNING THE SYSTEM.—The general method of alignment is as follows: Raise the automatic fire shutter, or open the gate of the projector mechanism, and pull the lamphouse against stop V, figures 327 and 347, in position for projection of motion pictures. Move the entire carriage, Q, figure 347 carrying the regulator and lamphouse forward until the

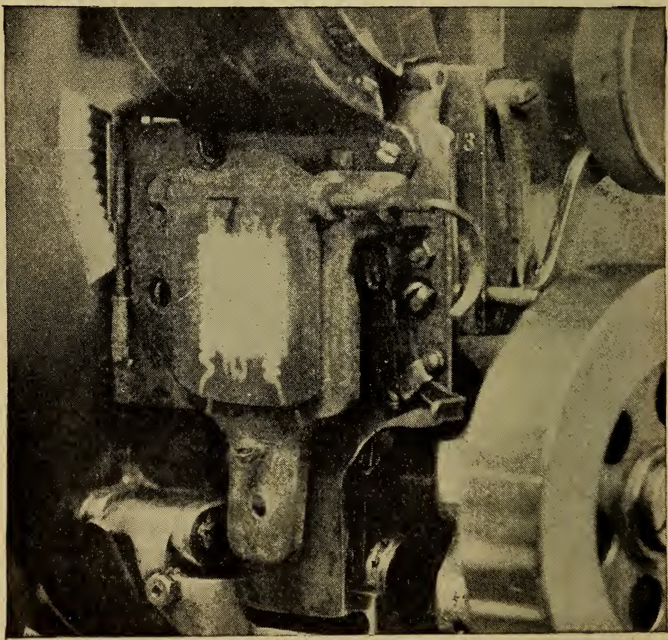


Figure 355

front surface of the condenser is 6.5 inches from the projector aperture plate—aperture plate, mind you, NOT the cooling plate, as in figure 356, except where state or municipal laws require a greater distance, which is law, but rather foolish law—that last being our own personal statement.

The remaining adjustments must be made with the lamp lighted. Place a piece of dark-colored, non-gloss surface cardboard in front of the projection lens, and move it forward and back until a position is found where the outline of the aperture and the cross wires, F 8, figure 353, are sharply focused on it, as in figure 357.

Loosen the four wing nuts, Z Z Z Z, Fig. 347, and raise or lower the lamphouse until the cross wires are centered up and down, as at B, Fig. 357, after which tighten wing nuts Z Z Z Z, finally checking to make certain that the cross-wires are centered, so far as up and down be concerned.

Next move the lamphouse to and fro on its carriage until the cross-wires are centered perfectly sidewise, as per D, Fig. 357. This is accomplished by screwing or unscrewing the carriage adjusting screw, W, 347. Caution: Be certain that when the cross-lines are centered both up and down and sidewise, as per D, Fig. 357, the motion picture position stop is shoved over against the condenser stop, S, Fig. 350. The condenser is now upon the optical axis of the aperture and projection lens.

ADJUSTING FILAMENT LAMP ON OPTICAL AXIS.—When adjusting a lamp for the first time, loosen mirror clamp-

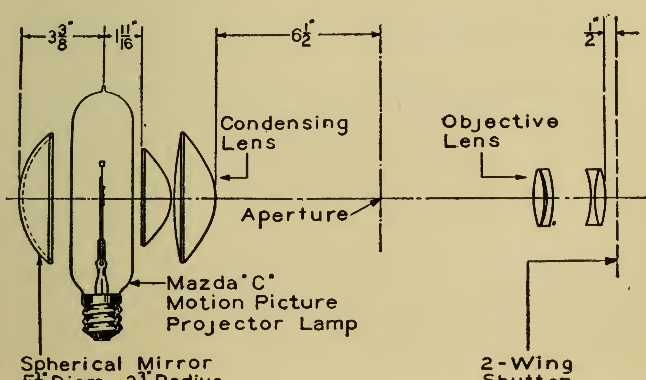


Figure 356.

ing nut, X, Fig. 347, and tip mirror either up or down, by means of handle Y, Fig. 347. The image of the coils of the filament will be seen on the automatic fire shutter, as per Fig. 349.

The lamp socket must be pushed in or out (toward you or away from you) until the image of the cross-wires in the

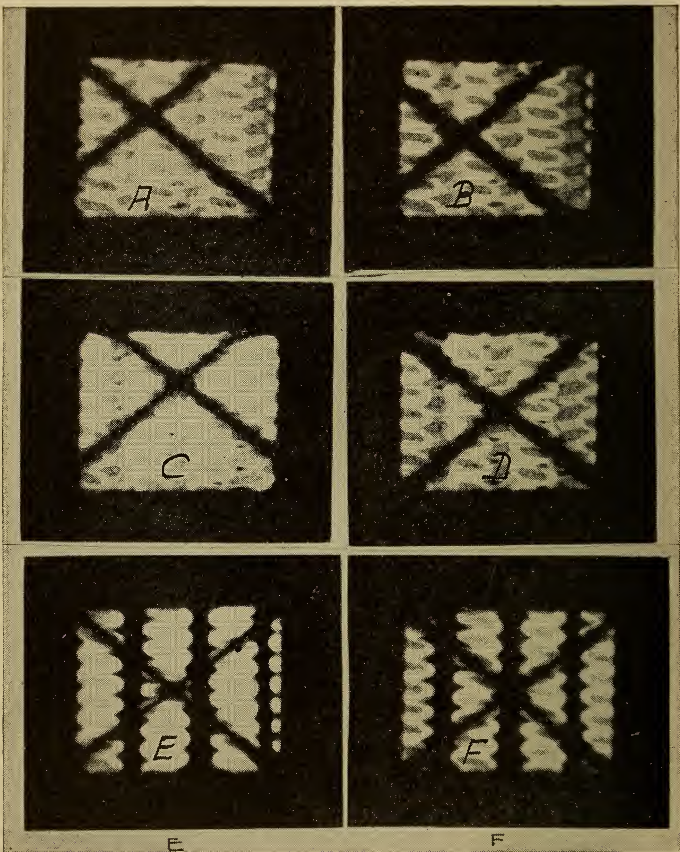


Figure 357

middle of the space between the two center filaments, F, Fig. 357. If the filament images are too far to the left, screw the small contact base adjusting screw on base K, Fig. 350, inward, which has the effect of raising the lamp out of the socket base.

Loosen socket base clamp T, Fig. 350, and move the lamp forward until the back face of the collector condensing lens (one next light source) is approximately 1 11/16 inches from the lamp filament, Fig. 356, and then tighten socket base clamp T, Fig. 350.

Now again check the location of the filament image, F, Fig. 357, and if found to be correct, tighten the lock nut, which has the effect of locking the lateral adjustment screw, M, Fig. 346, in position.

The optical train is in correct alignment if the cross-wires, as imaged on the cardboard held in front of the projection lens, are perfectly centered both up and down and sidewise, and their intersection falls between the two middle coils in the filament image, the spot on the coiling plate is small and centered on the aperture, the lamphouse against its stop and the motion picture condenser against its stop.

Close the dowser and the automatic fire shutter, or projector mechanism gate and an image of the lamp filament will appear on the automatic fire shutter. It only now remains to so adjust the mirror that the image of the coils which it reflects is properly meshed with the directly projected image of the coils, which may readily be accomplished by watching the image of the light source on a blade of the rotating shutter, or on the automatic fire shutter.

THE CINEPHOR CONDENSING SYSTEM.—The Simplex Division of the International Projector Corporation, makers of the Simplex professional projector, manufacture an incandescent equipment which employs a Cinephor Condenser. A general view of the Simplex incandescent outfit, with lamphouse doors removed and the condenser casing open is had in Fig. 358, in which Q is the swinging projector table, exactly the same as is used to support the Simplex type "S" lamphouse, or other Simplex arc lamphouses. To replace the arc lamphouse with an incandescent lamphouse it is only necessary to remove the former and set the latter in its place, being sure the base of the incandescent fits down into the grooves properly.

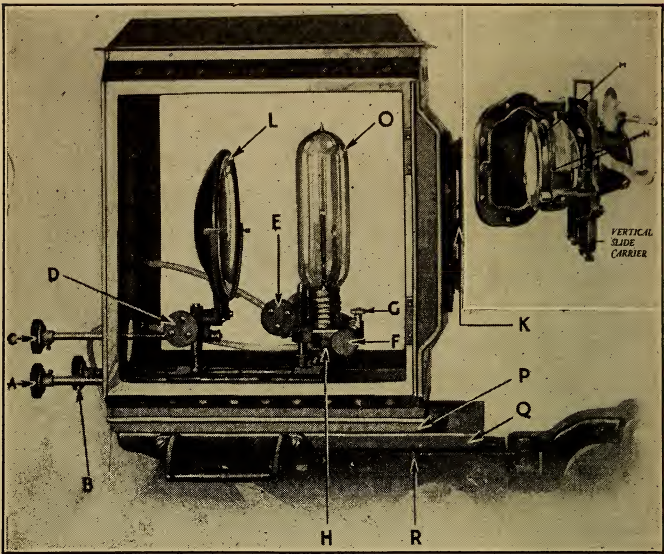


Figure 358

When the incandescent lamphouse is in place, be sure and tighten wingnuts (two of them) R, Fig. 358, which lock it to the swinging table.

THE CONDENSERS.—The condensers are in plainly marked wrapping. Unwrap and clean them. Unscrew condenser ring "M," Fig. 358. Insert smaller condenser in holder or ring provided. Screw ring back in place sufficiently to hold the condenser. Great care should be exercised against tightening the ring too firmly, since by so doing there will be no room for the lens to expand when heated, which may cause the lens to break. First put ring with condenser in the groove "M," Fig. 358. The larger condenser should be placed in groove in mount "N." Position of the condensers with regard to surfaces is shown in Fig. 359, which also gives the distances to be observed in the general line-up.

CURRENT CONTROL.—In order that continuity in action may be had, we shall place a description of the current control

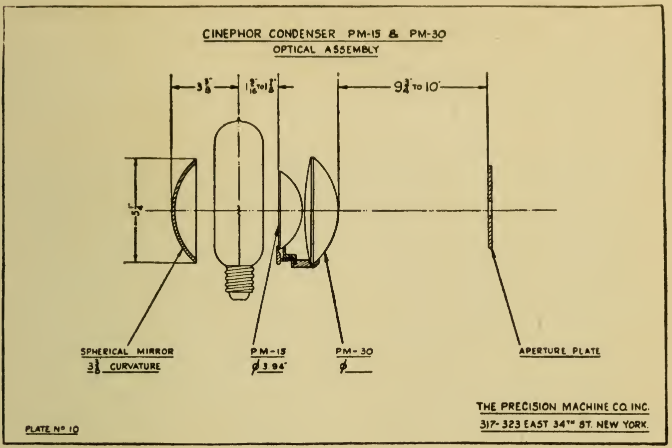


Figure 359

here, because before attempting some of the operations described further along it is necessary that current be available at the lamp.

Where the current supply is D. C. the lamp takes current through a rheostat, which has such fine adjustments that very slight changes in current (amperage) may be made by the projectionist. This apparatus is illustrated in Fig. 360, in which the method of wiring is shown, A being the amperage regulator. Do your wiring according to the diagram in Fig. 360 and you will be correct.

If the current supply be A. C., then a General Electric step-down transformer, with handle for regulating current output to lamp, is used.

CONNECTING REGULATOR.—The connections for a single lamp are shown in Fig. 361. Connect the line wires, through a D. P. S. T. knife switch of sufficient capacity, and 20 ampere fuses if the current be 100 volts (if 220 volts, then use 10 ampere fuses) to the terminals marked "LINE" at bottom of regular panel).

CAUTION.—Regulators must not be used on any voltage or current frequency except as per markings on name plate of each regulator.

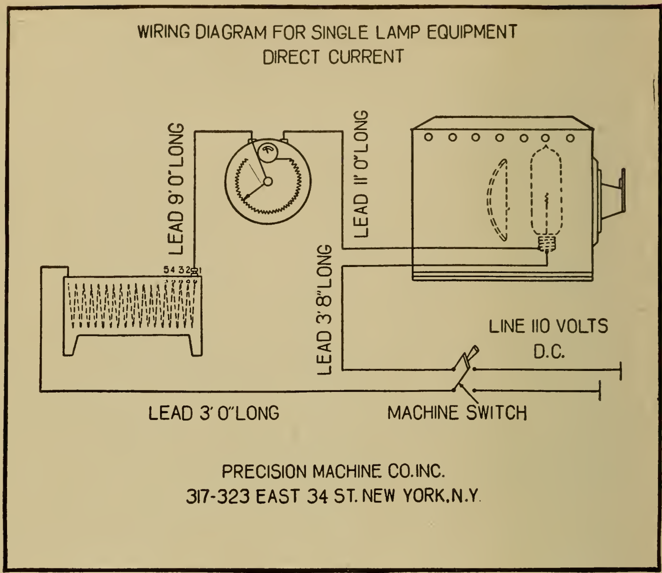


Figure 360

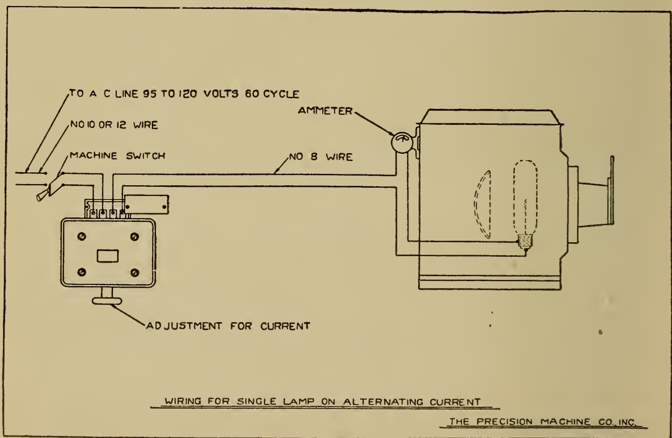


Figure 361

CAUTION.—We strongly advise that the meter be located where it will be in constant view of the projectionist when in position beside the projector. It is essential to have close regulation of the current and this is induced by having an ammeter at all times directly under the observation of the projectionist.

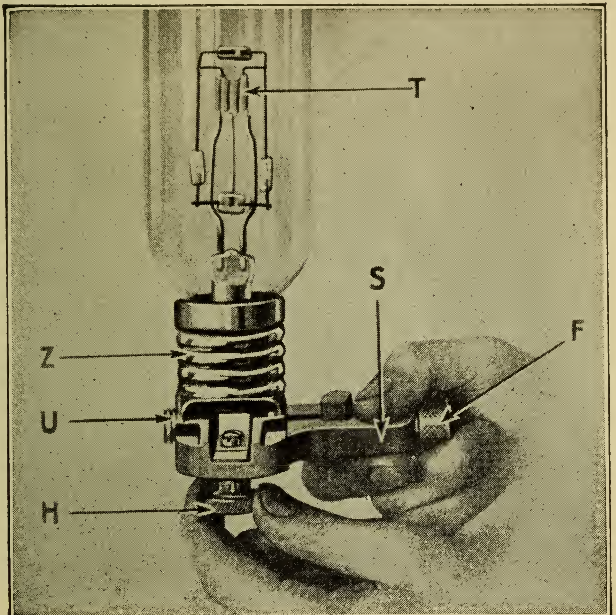


Figure 362

CAUTION.—After installing a new lamp, always examine the ammeter, and by means of the adjusting handle, so regulate the current flow that it is just 30 amperes.

If you want maximum service from your lamps you must have EXACT accuracy in current flow, and that may only be secured by the use of a good ammeter.

TAKE NOTICE.—We strongly recommend that users of Mazda projector lamps have their ammeters tested at least once a year. It will pay you to do it. An ammeter registering low

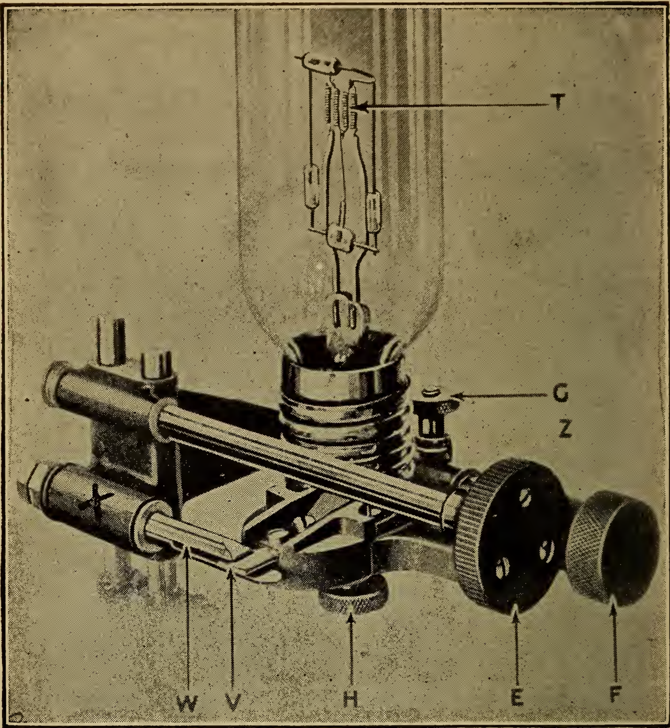


Figure 363

will cause constant overloading of your lamp filaments, and thus very greatly shorten the life of the lamps.

We would also caution you against deliberate overloading of lamp filaments. The projectionist may get much more light by boosting the amperage above the rated capacity of the lamp when a dense scene comes through, but this practice should strongly be advised against as it greatly shortens the length of life of the lamp. Under no condition should the current exceed 30 amperes.

Never use such an outfit as is shown in Fig. 360 except for D. C. If your current is A. C. use the regulator as shown in

Fig. 361. The rheostat may be used on A. C., yes, but by comparison with the regulator it is extremely inefficient and wasteful.

THE LAMP HOLDER.—The lamp used is a 900 watt, 30 ampere, 30 volt Tungsten filament lamp. The coils of such a lamp are shown, full size Fig. 317. The lamp is held in a socket Z, Fig. 362 very similar to the ordinary lamp socket, except that the lower central contact of the socket is movable, or adjustable as to its height.

Examining Figs. 362 and 363 you will note knurled-head thumb screw H. The upper end of this screw presses against a spring blade, which is raised as the thumbscrew H is screwed in, and is lowered as it is screwed out, or down. The center contact of the lamp makes contact with this spring blade which carries current to the lamp from one side of the line. The need for this adjustment is as follows: When the lamp is inserted it is screwed into the socket as far as it will go, but in this position it is probable the filament will not face the lens squarely. It will therefore be necessary to unscrew it a part of a turn, which has the effect of altering the distance the center contact of the lamp will be from the bottom of the socket when it, the lamp, is in operating position. From this you will understand the need for the center contact of the lamp being adjustable as to height. The detail of this contact is diagrammatically illustrated at A, Fig 364. The lamp holder, as a separate unit, is shown in Fig. 362.

TO PLACE LAMP IN HOLDER.—First lower knob H, Fig. 363, as far as it will go. Then screw lamp into socket as far as it will go, then see if the face of the filament is parallel with (in line with) knob F, Fig. 363, and the shaft it controls. If not, then unscrew the lamp from the socket enough so that the filament is in line, whereupon tighten the knob H, Figs. 362 and 363 until firm contact is made with base of lamp. The tightening of knob H serves two important purposes, viz.: (A) It forms electrical contact between the lamp base and contact strip, as per Fig. 364. (B) it locks the lamp into the socket, thus making good electrical contact between the metal of the socket and the metal of the lamp base. **You therefore will understand the importance of setting knob H up firmly.**

PLACING LAMP IN LAMPHOUSE.—Each lamp must first be placed in a holder as per preceding instruction, and the holder afterward installed on the lamp base in the lamphouse. The method of connecting the holder to the base is simple;

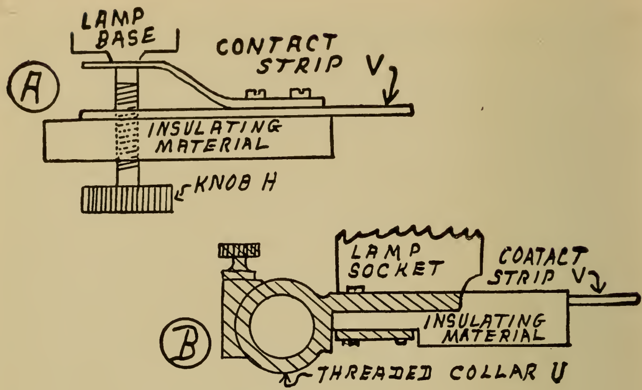


Figure 364

also its removal from the base is equally simple. To install a holder containing lamp, proceed as follows. In Fig. 363 you see contact strip V. At A, Fig. 364 you see what it is and what it connects to. In Fig. 363 you see the side of lamp holder opposite to the side shown in Figs. 363 and 365, and at B, Fig. 364, you see a drawing of the back end of the lamp holder. As shown at B, Fig. 364, threaded collar U. Fig. 364 is really a hollow shaft, on the opposite end of which knob F, Fig. 363, is mounted.

To insert the lamp holder, shove it past knob E, Figs. 363 and 365, and engage contact strip V, Fig. 364, with slot in part W, as shown, Fig. 363 at the same time entering a stud which protrudes from lug Y, Fig. 365, into the hole in end of threaded collar U, Fig. 364, and above the holder in as far as it will go.

By way of explanation, a metal stud passes through and is gripped and held by lug Y, Fig. 365. To one end of this stud wire X attaches, as shown. The other end extends beyond the left hand end of lug Y to a considerable distance, and forms the support for one side of the lamp holder. It also forms the current carrying connection between Wire X and lamp socket Z, Fig. 365.

CAUTION.—After inserting lamp holder be sure and tighten thumbscrew G, Fig. 365, which locks parts S and stud into

good electrical contact. Unless this be done there may be arcing between the two parts, which may, in time either injure or ruin them.

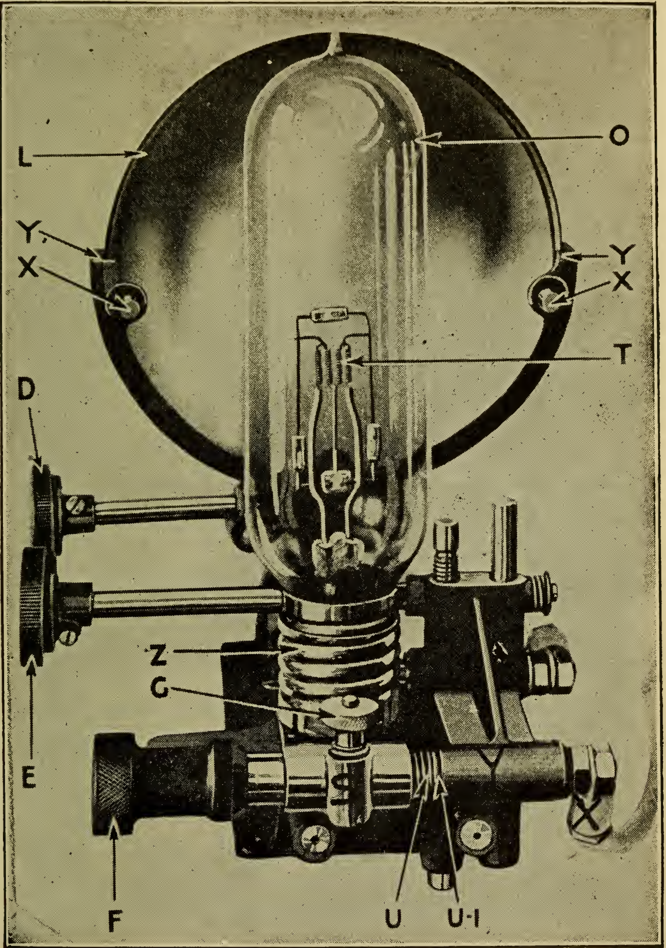


Figure 365

THE MIRROR.—In order that the light from the back side of the filament be not wasted, and that the light source present to the lens a solid unbroken surface, a spherical mirror is employed placed as per Figs. 365 and 366. The reasons for this mirror, and an explanation of its action will be found in the text matter, page 817.

It is of course vitally important that the mirror be so placed that the image it reflects or projects will fall exactly in its appointed place, and the Simplex equipment provides ample adjustments, in convenient form, to enable the projectionist to place the image exactly where he wants it.

CLEANLINESS.—It is essential to efficient results that the mirror be kept perfectly clean. You must polish its surface daily. This may be done by washing it with a solution of half wood alcohol and half water, or with gasoline, polishing the surface while still wet. It may also be done by breathing on surface while mirror is still cold and polishing with a perfectly clean, soft cloth, or with tissue paper.

We would recommend to theatre managers that they provide, for the purpose of cleaning lenses, a roll of soft high grade toilet paper. Such paper is most excellent for the purpose, and clean lenses mean much in excellence of screen results.

To remove or insert a mirror it is only necessary to loosen thumb screws X X X, Figure 366, and insert or take out the mirror, as the case may be.

CAUTION.—After inserting a mirror be sure to tighten thumb screws X X X, but only sufficiently to hold the mirror in position, without exerting undue pressure. **DON'T jam the thumb screws down tight, unless you want a broken mirror.**

DISTANCE. FILAMENT TO MIRROR.—Distance center of back of mirror from lamp filament must be as shown in optical diagram, Fig. 359. This is important to good results. The correct distance may be obtained by turning knob A, Fig. 366 in the required direction.

Having placed the mirror in position and secured the correct distance back of mirror to lamp filament, unlock the mirror by turning knob D, Fig. 366, to the left, and swing the mirror to one side as far as it will go by means of knob C. Fig. 366 locking it there by means of knob D. This is to prevent focusing the filament image, which is not desired at this stage of the proceedings.

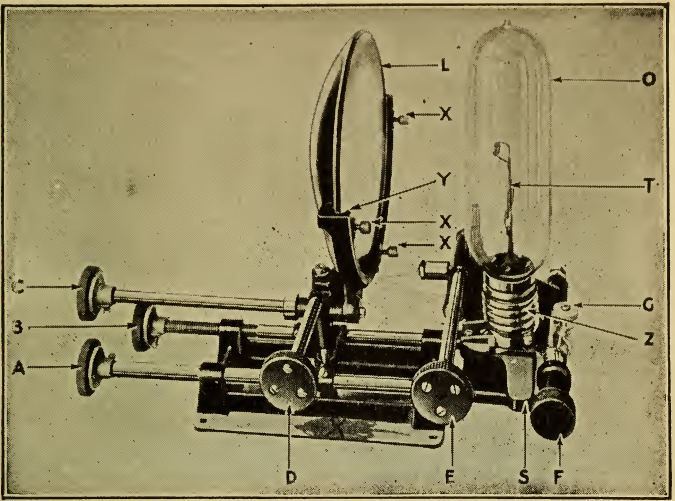


Figure 366

LOCATING THE LAMP FILAMENT IMAGE.—In center of dowser of lamphouse there is a pin hole. Light the lamp and unlock mirror by turning knob D, Fig. 366, to left and swing mirror over by means of knob C, Fig. 366. The image of the lamp filament is now seen. This filament image should now be centered on the automatic fire shutter. When this is accomplished the image will appear as indicated on Fig. 367, A.

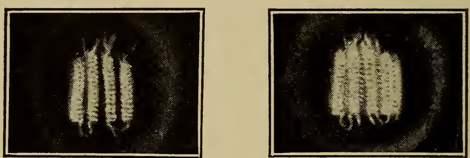
The image fairly filling the opening of the cooling plate, it will be noted that dark spaces remain between the filament coils as on A, Fig. 367.

NOTICE.—If it is desired to move the lamp toward you it is only necessary to turn knob F to the right, but if you wish to move the lamp from you, you must turn knob F to the left, AND AT THE SAME TIME SHOVE THE LAMP HOLDER IN. This is because the threads on threaded collar U, Fig. 365, engage with threads in part S. Fig. 365, while collar U merely butts up against the end of lug Y, hence turning knob F to the right will pull the lamp back, turning it to the left will have no effect, unless you shove in on the holder at the same time. Examine the parts and you will see how it works.

Be sure and tighten thumbscrew G, Fig. 366, when you are through.

FOCAL DISTANCES.—Examining the optical diagram, Fig. 359, you will see what the focal distances must be. They are the distances recommended by the manufacturer of the apparatus, who certainly should know what is best.

CAUTION.—DON'T GUESS AT DISTANCES. USE A RULER AND GET THEM EXACTLY RIGHT. You are not working with an arc lamp now, and cannot make surplus light available to offset the waste attendant on "guess work," therefore stop guessing and do your work right if you want satisfactory results.



A Figure 367 B

LOCATING FILAMENT.—The lamp filament must be 1-9/16 to 1-7/8 inches from the face of the collector lens, as per Fig. 359. By means of knob B, Fig. 366, move the lamp backward or forward until, using a ruler, you have the filament exactly that distance from the face of the lens. When you get the filament the right distance, close the lamphouse door and move the filament locater in the lamphouse door backward or forward until you can see the lamp filament through it, whereupon tighten the holding screws of the locater. This device is to enable you to place the filaments of new lamps you install the correct distance from the lens. Once set, as above when you install a new lamp you have but to move it backward or forward until the filament can be seen through the locater tube, and it is exactly the right distance from the lens. It is very important that this distance be precisely right.

FOCUSING THE MIRROR IMAGE.—It is now time to bring the mirror image into play. It will be noticed that by swinging knob C, Fig. 366, to right and left that another image will appear on the cooling plate slightly fainter than that of the lamp image. This is called the mirror image, and should be centered first, that is centered up and down by means of knob D, Fig. 366, until the proper height is obtained (which should be the center of fire shutter). This image must then be focused by turning knob A, Fig. 366, forward or backward until clear definition is obtained. This image after the best definition has been obtained must be moved horizontally and so placed as to fill in the dark places of the lamp image and locked by means of knob D, Fig. 366.

Next by turning knob A, Fig. 366, the mirror image is made as sharp as possible and then, using knob C, Fig. 366, which swings the mirror sidewise, and knob D, Fig 366, which causes the image to raise or lower, so locate the mirror image that it exactly fills the space between the filament coils, so that the image appears as at B, Fig. 367.

The entire adjustment should now be complete and correct, and the screen field should be clear. Should there be discoloration, slowly move the entire lamphouse backward or forward until it disappears, after which tighten wing-nuts (two of them) R, Fig. 358.

EXTRA LAMPS.—It is necessary, or at least highly advisable that one or more extra lamps be on hand, adjusted in spare lamp holders and all ready for immediate insertion in the lamphouse. Failure to take this precaution may, and probably will cause an embarrassing situation as the audience waits while you install a lamp in its holder, and the holder in the lamphouse, the first named proceeding probably requiring a longer period of time than the second.

INSTALLING EXTRA LAMP IN LAMPHOUSE.—First, before attempting to remove the old lamp, be sure the projector table switch is "Open." Then, having the spare lamp properly installed in its socket, as per instruction already given, loosen thumb screw, G, Fig. 366, and pull old lamp and its holder out, after which insert the holder with new lamp as per instruction: "Placing Lamp in Lamphouse." Next close projector table switch, bring lamp up to normal amperage, center filament image on automatic fire shutter and mirror image between coils. Resume projection, and if necessary, move lamphouse backward or forward to get as clear a field as possible until opportunity is had to complete a perfect adjustment.

NOTE.—If current be D. C. move regulator to "Low" as soon as projector table switch is pulled. If current is A. C. set regular line voltage switch at "LOW" as soon as table switch is pulled.

BRENKERT SPOT AND FLOOD LAMPS

As applies to motion picture theatres this equipment is for small spotlighting or flood-lighting, with or without static colors, at long or short distances. The apparatus is well made throughout.

Figure 368

The spot and flood lamp shown in Fig. 368 accommodates a six inch diameter, twelve inch focal length lens. Any size carbon may be used, from ⅜ Silver Tip negative to a one inch diameter cored positive. The arc lamp is well made and has all necessary adjustments in good form.

The apparatus is supplied without rheostat if it is to take current from a motor generator, or with suitable capacity rheostat (40 to 100 amperes) if it is take current directly from the lines.

The lamp is equipped to accommodate standard size color wheels, color box or color slides; also with an iris shutter. Fig. 369 shows the "framing shutter" built into the lamphouse. It is operated by a suitable control located on the rear of the lamphouse. The purpose of this shutter is to permit the control of the top and bottom of the light beam, so that the projectionist may flood the full width of the stage without spilling light on the proscenium above the stage, or into the orchestra pit.

DIMENSIONS.—The Brenkert spot-flood lamp, Type C-3, has the following dimensions: Lamphouse 26 inches long, by 22 inches high, by 9 inches wide. Minimum height from floor

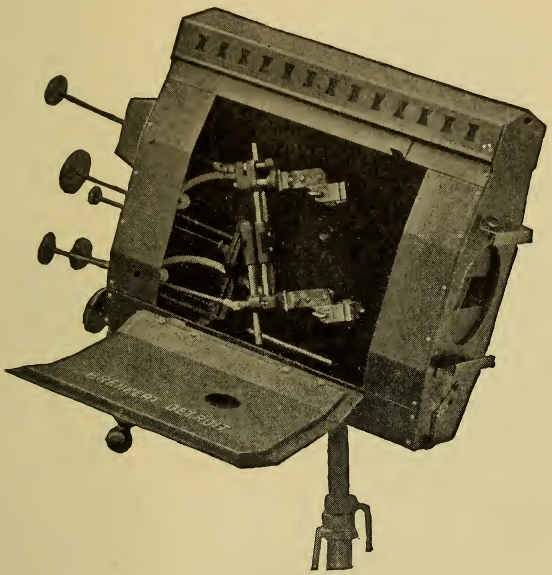


Figure 369

to lens center when lamphouse sets level, 43 inches. Maximum height 74 inches. Minimum height over all 57 inches. Maximum height over all 88 inches. Net weight without rheostat 87 pounds. All parts of this apparatus may be purchased for replacements.

BRENKERT COMBINATION COLOR EFFECT PROJECTORS.—As applies to motion picture theatres, serve three purposes, viz: Spot and floodlighting with dynamic or combination colors, scenic effect projection and lantern slide projection.

BRENKERT COMBINATION COLOR EFFECT PROJECTOR.—Type "F-3," is shown in Fig. 370. By means of this apparatus many very charming effects and color combinations may be projected. The device is, in effect, a specially constructed double type stereopticon with many additions. It is very carefully balanced on its pedestal, so that it may be instantly pointed in any direction, the same as may a spot or

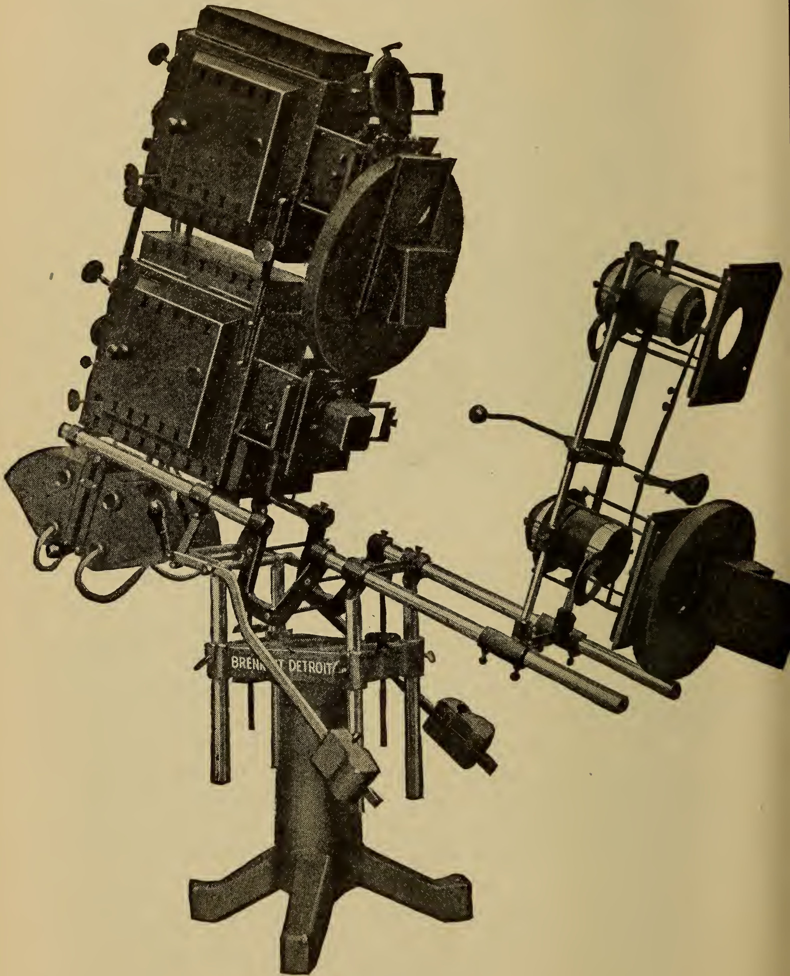


Figure 370

flood lamp. The swing, or sidewise motion, is carried by ball bearings, and the counterbalance such that the up and down movement is accomplished with but a slight effort, the head remaining in any position in which it may be left.

Two five-inch-diameter iris shutters are mounted directly in front of each condenser. These are controlled by suitable levers, conveniently located. They are for the purpose of regulating the size of spot or flood on stage or orchestra pit.

Figure 371

Immediately in front of the iris shutters are framing shutters such as are shown in Fig. 371. By means of these and their possible adjustments, the projectionist may project either a horizontal or a vertical light beam, of any desired width or height, or he may project a perfectly square beam if he so desires.

In grooves in front of the framing shutters an adjustable star shutter may be mounted and by its use a perfectly formed five-pointed star may be projected, of any desired size and color. The size of the star may be altered at will merely by moving a conveniently located lever.

Two projection lenses, of different focal length, are mounted on both the upper and lower unit, as per Figs. 372 and 373. They are mounted on swivel collars so that they may be quickly thrown into position in the light beam, or just as quickly removed therefrom. The lens nearest the slides is of correct focal length to project a flood of light over the entire stage, or orchestra pit, as may be desired. The lenses nearest the slide carriers are of proper focal length to project a light beam about the size of a motion picture screen.

When it is desired to flood the stage or orchestra pit the shorter focal length lens is swung into position, while the longer focal length lenses are thrown out of the light beam, or vice versa if it is desired to project slides.

By means of the two focal lengths of projection lens, the iris aperture controlling shutters, the framing shutters and the

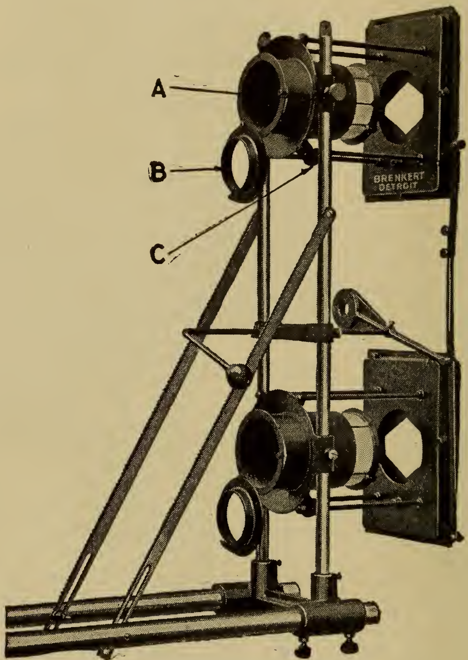


Figure 372

REAR VIEW OF THE DUAL FOCUS PROJECTION LENSES

"A"—Front or long focus projection lenses in position ready to project moving scenic effects, moving color effects, or slides on to the motion picture screen. "B"—Rear or short focus lenses swung out of position. "C"—Fine focussing adjustment for either the long or short focus lenses.

NOTE—Both dissolving shutters are now open for projecting from both lower and upper unit simultaneously with either two color effects or two scenic effects.

star shutters, complete flood and spot lighting is accomplished through the one apparatus; also by reason of the fact that both condenser and projection lens is employed, both flood and spots have even illumination over their entire area, and are very white. There are no aberrations or discolorations such as are inevitable when only a single lens is used as in the ordinary spot lamp.

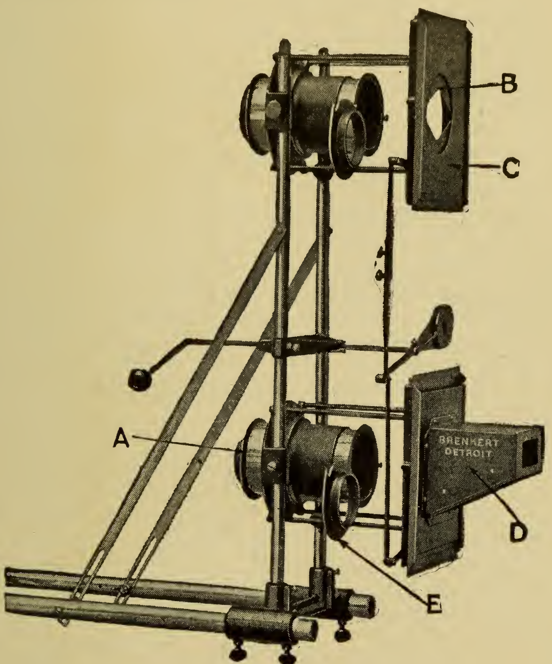


Figure 373

FRONT VIEW OF DUAL FOCUS PROJECTION LENSES

"A"—Rear or short focus lenses in position ready to project moving scenic effects or moving color effects over the entire stage opening. "B"—Dissolving shutters for dissolving from one effect or slide to the other. These shutters are adjustable to gradually close one while opening the other or both open at the same time. "C"—Front effect holder for color effects which must be cperated in front of the projection lens. "D"—"Rainbow" (Prism) effect in place. "E"—Front, or long focus lenses, swung out of position.

COMBINATION COLOR PROJECTION.—Since in this apparatus there are two separate light sources and two separate lens systems, two different colored beams may be projected, which may be of different cross section, or area. For example: The entire orchestra pit may be flooded with any desired color, while the orchestra leader may be spotted with white, or a different color, or the organ console may be flooded with one color, and the organist with white or another color spot. The same principle may, of course, be applied to the stage itself, the stage being flooded with one color, and one character, or group of characters spotted with white or a color. It is also possible to project a large star of any desired color, with a small, round spot of white or a different color in its center wherever it may be desired. The projectionist may follow an actor with spot just as readily as though he were handling an ordinary spot lamp.

DYNAMIC EFFECTS.—For projecting dynamic color effects a motor wheel driven by a spring is furnished with this projector, together with six glass design slides. These latter are placed in the slide carrier, and are focused upon the object to be illuminated. The color wheel is placed in front of the projection lens and rotated by its spring motor. The wheel has a large number of colors, which produce a dissolving effect from one to the other. The wheel may be set to rotate at different speeds.

Two color wheels are supplied with this projector, designed to be placed directly in front of the condensing lenses, the slide carrier and its holder being moved up out of the way. The color wheels are both hand operated. They are to facilitate the projection of combination colors.

It has been the experience of theatres which have used these projectors that the combination and dynamic colors create greater interest than single static colors as projeced by the ordinary spotlamp.

Scenic effects may be used on this projector. They may be either purchased outright or rented from the Brenkert Company. They are placed on the projector immediately in front of the framing shutters, the slide carriers being moved up out of the way, and are focused through the short focal length lenses used for flooding, as before described, on a drop covering the entire stage opening, or by means of the other, longer focal length lenses through which slides are projected, they may be focused on the motion picture screen. They may be projected singly through one lens system, or two may be projected, one through each lens system, in combination. The projector may be used as a plain stereopticon as well as for the effects described, which same is done in many of the smaller theatres. In large theatres, however, they are usually used entirely for spot and flood lighting effect work, a separate stereopticon being installed for ordinary slide projection.

Some of the effects available, through purchase or rental with this projector are:

Brenkert Catalog No.	
CE1	Aurora Borealis, changing color effect (hand colored).
CE2	Babbling Brook (hand colored).
CE3	Blizzard effect.
CE4	Burning forests, panorama (hand colored).
CE5	Clouds passing moon, moon stationary.
CE6	Moving Fleecy clouds with rising moon.
CE7	Country Scene, panorama (hand colored).
CE8	Cyclone effect.
CE9	Cyclone with flying objects (hand colored).
CE10	Descending clouds, for imaginary ascension trip.
CE11	Falling Flowers (hand colored).
CE12	Flying Angels.
CE13	Flying Birds.
CE14	Flying Butterflies (hand colored).
CE15	Fog effect.
CE16	Flood with floating objects.
CE17	Falling Flags (hand colored)
CE18	Fire and smoke effect (hand colored).
CE19	Flames (hand colored).
CE20	Inferno spectacular effect (hand colored).
CE21	Lightning effect, three brass slides, used in slide carrier, with lightning shutter, used in effect holder.
CE22	Moon picture slides, with appearing and disappearing clouds (hand colored).
CE23	Moonlight water ripple, with metal mask.
CE24	Fast moving, dark, storm clouds.
CE25	Slow moving fleecy clouds.
CE26	Moving evening and sunset clouds (hand colored).
CE27	Moving river (hand colored).
CE28	Midnight sun (hand colored).
CE29	Ocean Waves (hand colored)
CE30	Rain effect.
CE31	Rainbow Prism effect, with metal mask (portrays natural rainbow).

CE32 Sand storm effect (hand colored).
CE33 Snow storm effect.
CE34 Volcano effect, used on triple dissolving projector or three spotlamps:
Eruption (hand colored).
Flowing lava (hand colored).
Rain of fire and ashes (hand colored).
CE35 Water falls effect (hand colored).
CE36 Automatic revolving color wheel (5 colors and one white light, driven by spring motor).
CE37 Blending of color effect, with glass design slides.
CE38 Waving American flag effect.
CE39 Flying Bluebirds (hand colored).
CE40 Flying fairies.
CE41 Falling sunbeams.

Special effects are also made to order.

We have given an extended description of this projector, because we believe it to be a device which, properly handled, can be made to add very much to the programme of a theatre The regular Brenkert F-3 Combination Color Effect Projector has very large lamphouses and large condensers. The apparatus is such that 100 amperes may be used in each lamp, or a total of two hundred for the two. This apparatus is designed for use only in the largest theatres. For smaller theatres, smaller lamphouses are supplied, which accommodate lamps of sixty ampere capacity, or a special equipment for Mazda is supplied if desired.

INSTALLATION.—Front wall of projection room to center of pedestal, 48″. Front wall to extreme rear of projector, 84″. Over-all height, six feet. Over-all width 20″. Pedestal feet require the area of a 27″ circle. Minimum distance recommended between two F-3 projectors, three feet center of pedestal to center of pedestal. One port is required in projection room wall, same to measure 30″ wide by 32″ high, in the clear. Where projection angle is ten degrees bottom of port to floor from 22″ to 32″, the stand has a nine inch height adjustment. If the pitch is greater than ten degrees the port opening should be slightly closer to the floor. If less than ten degrees, it should be slightly higher. Vertical distance center of upper to center of lower lens is 19 inches. Net weight of entire projector 225 pounds.

SPOTLAMP COLOR EFFECTS.—It is possible to project one color effect at a time by means of an ordinary spot lamp, with additional attachments, provided the projection distance

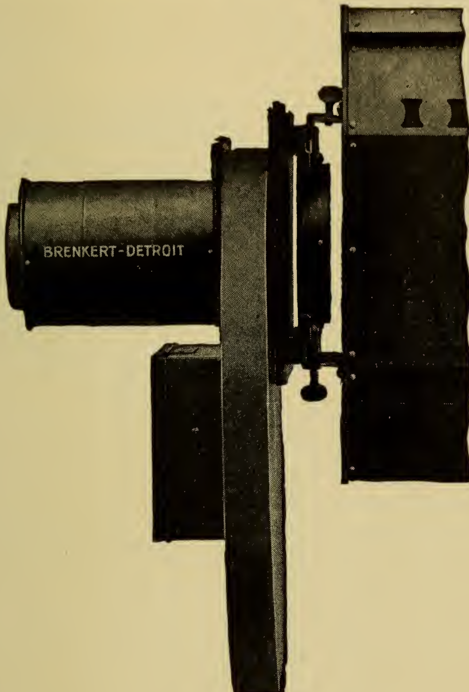


Figure 374

be not to exceed seventy feet. A motor driven color wheel or scenic effect may be attached as shown. Combination color effects cannot be projected from a spot lamp.

THE WEAVER MOTOR CURTAIN CONTROL

The Weaver Bros. Mfg. Co. put out a machine for handling the curtain in theatres. They use a specially designed motor which permits of the device being handled—put into action or stopped—from as many different places in the theatre as may be desired. The device may be reversed or stopped at will. It is not necessary to stop the device before reversing. It has neither batteries, relays or contactor switches. The only switches used are standard three-way and four-way switches, hence, the liability of switch trouble is reduced to a minimum.

The motor journals have oil wells and oil rings instead of the journals being oiled by means of a wick. See figure 148, page 499.

The gear reduction train is ball bearing and is packed in hard grease, calculated to give very long service without attention.

The drive to the curtain is by means of a ⅜" tiller rope (tiller rope has steel core with braided cotton covering) running in V pulleys, which provides maximum tractive power without slippage, together with minimum probability of trouble. Also it simplifies installation, as device does not have to be lined up so accurately with curtain sheaves.

The curtain may be instanly freed from the motor control device, so as to be operated by hand; also it may be instantly attached again when desired. In these operations it is impossible to get the curtain "out of time" with the device. You may detach and attach the control device at any desired point in the opening and closing operation and the control will still start and stop the curtain exactly at the right point. Slippage of rope does not affect points at which curtain will start or stop.

Weaver Bros. also make one style of control that mounts on the sloat, permitting the whole curtain to fly as well as the barn door effect, or both effects at once. This model is along the same general lines as the one described except, that it cannot be operated by hand, owing to its position on the sloat. All the parts possible are made from aluminum, instead of cast iron, in order to reduce weight. This model is becoming very popular because of the different effects that can be secured through its use.

WIRING.—The motor is specially wound, single phase, and has three terminals, No. 1, 2 and 3. No. 1 lead is the neutral wire and connects to stop circuit. No. 2 and 3 connect to breaker switches, which are in the reversing circuit. The stop circuit is no more than one side of the line run through a series of three-way and four-way switches, and the revers-

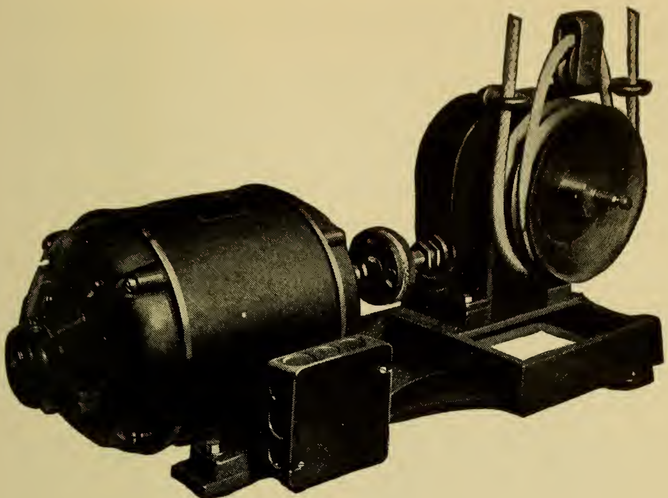


Figure 375
Weaver Curtain Control

ing circuit is the other side of line run through, first a three-way, and all other switches in this circuit four-ways; from one corner of the last four-way to one breaker switch and from breaker switch to motor terminal No. 2; from opposite corner of last four-way to other breaker switch and from breaker to motor terminal No. 3; leads to motor terminals No. 2 and 3 may be reversed to cause motor to run in proper direction. As many switches may be installed as desired. We recommend at least one station back stage and one station at each position in projection room from which the projectionist is required to operate curtains.

Breaker switches are of a standard make of switch, mounted with special bracket, in such a manner that the curtain itself causes them to operate, one for closed and one for open position, thus making it impossible to get curtain out of time with control device.

It is a general practice also to wire in pilot lights which indicate position of curtains, for instance many theatres use two and three curtains and it is impossible for the projectionist to see what position the back curtains are in unless there is some means to indicate the positions, although this is not absolutely necessary.

The design of the device indicates extreme simplicity, the entire unit consisting of one one special ¼ H. P. repulsion type motor, worm reduction gear, base 6″ double V pulley and rope guide. Floor space is 10″ x 26″ x 15″ high.

The Weaver is fully guaranteed by the manufacturers to give perfect satisfaction.

THE VALLEN CURTAIN MACHINES AND NOISELESS CURTAIN TRACK

The Vallen machine for handling theatre curtains is made in three sizes, viz the "Junior," which is made to handle small curtains, "The Vallen," which will handle almost any size curtain if it be properly installed, and the "Vallen Special," which is a heavy duty machine, designed to automatically handle any object which requires from 75 to 225 pounds pull or pressure to set it in motion.

Figure 376 shows the general appearance of the machines, which are all essentially the same, except as to size and power.

These machines are equipped with remote controll switch, so that thy may be set into motion from any desired station in the theatre, at which point they may also be instantly stopped, or revrsed. In other words, from the operating station the man in charge may close the curtain or open it, or he may start to close or open it, and may reverse the motion at will at any point. Also the power may be quickly disconnected and the curtain operated by hand power.

The machines are well made, and have been thoroughly tested out by some years of service. They are commended to your favorable consideration.

The Vallen Electrical Company, Akron, Ohio, also market a noiseless curtain track, which is shown in figure 377. It is not a box or steel track, but consists of two carefully selected maple rails, chemically treated and anchored to metal

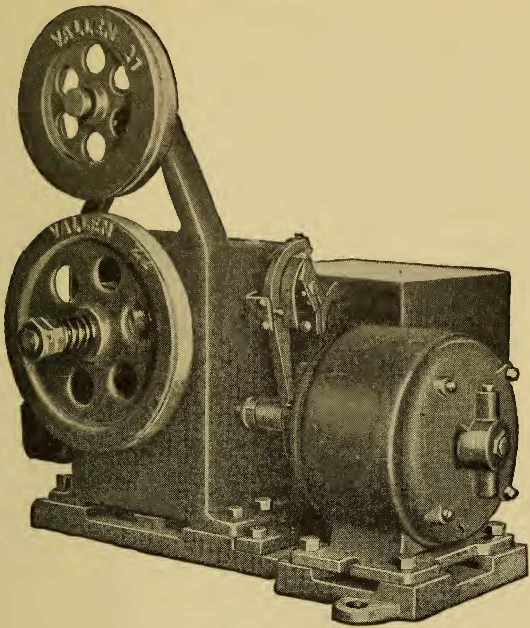


Figure 376

hangers every eighteen inches. It is in turn, anchored to the ceiling, or to a frame swung from the grids by bolting through the hangers. The curtain is attached to slides which

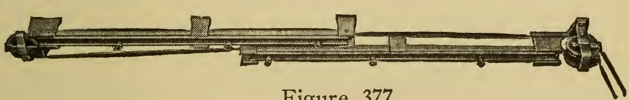


Figure 377

operate inside the track. They also are made from maple. The track will take care of the largest curtain, and every known contingency in curtain handling has been taken care of.

AUTOMATIC DOUSER

AN ELECTRIC DOUSER.—The change-over is facilitated by what is known as the Weaver Electric Douser, which works by magnetic action and cuts off the light from one projector, substituting that of the other simultaneously, or at least in the very small fraction of a second. The action is in fact so rapid that it is practically instantaneous.

In Fig. 378 we have the photographic view of the douser, and in Figs. 379 and 380 wiring diagrams for two and three-projector installations. It is also quite possible to add other switches so that the douser may be set into acion from any desired point in the projection room, through this latter we do not either, value or recommend, because we hold that the

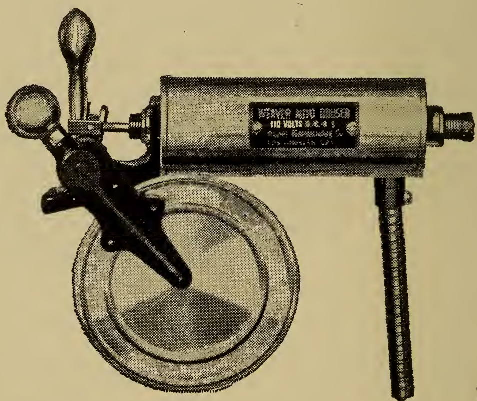


Figure 378

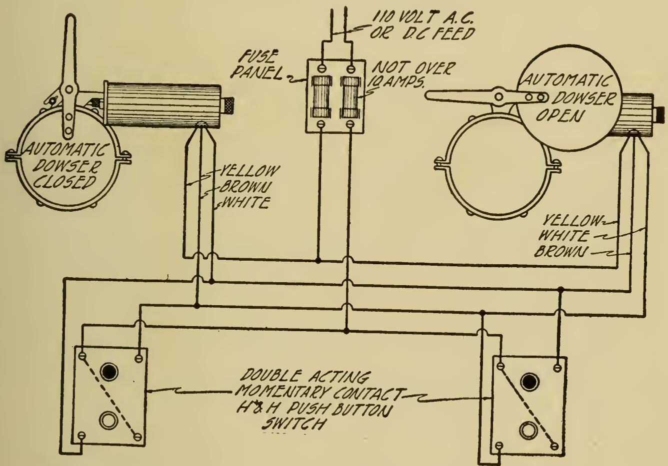
projectionist should be beside the projector, where he rightly belongs when a picture is being projected.

The douser is clamped to the top of the condenser cone by means of a market. One push button switch is located on or near to each projector. It is possible to locate other push buttons at the re-winder table or elsewhere, if desired. These switches must, however, be of such type as will make contact ONLY when the button is pressed down. If the current be D C, then it is advisable to use an "H and H" switch. In any event if the current be DC a switch that will not arc must be selected. If the current be alternating, then any type of momentary contact may be used.

CAUTION.—Switch should always be kept lubricated to prevent possibility of sticking. The douser circuit must be fused, and the fuses must not exceed ten (10) amperes capacity.

Wires attached to douser are colored. Yellow wire connects douser to line, through a S. P. S. T. knife switch. Light brown wire closes douser. It is attached to white wire of other douser, and through it to one terminal of each switch, as shown.

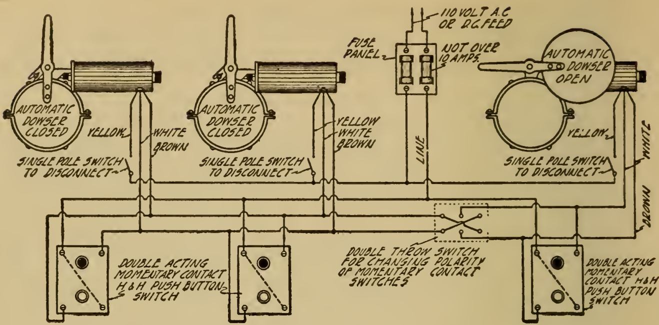
White wire connects to brown wire of other dousers, and through it to one pole of each switch. The third pole of the switches connects to the line. It is all made very plain in Figs. 379 and 380.



WIRING PLAN-TWO DOWSERS-TWO SWITCHES

Figure 379

CAUTION.—Before connecting white and light brown wires to switches, test the circuits and see that they are open except when switches are operated. All momentary contact switches have two "hot" legs. They are sometimes bridged across one end and sometimes from corner to corner. Always test to determine which, as it will make a difference in



WIRING PLAN—THREE DOWSERS - THREE SWITCHES

WEAVER AUTO DOWSER

PATENTED FEB 1, 1921

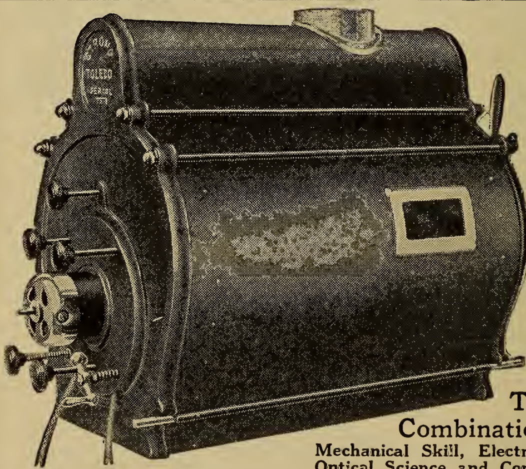
Figure 380

necessary connections to switch. Diagrams show H and H switches which are bridged across from corner to corner.

Should dousers open or close too far, or not far enough, loosen lock nuts at end of coil box and screw the brass bumpers in or out, as need may be until the correct adjustment is had.

Should douser fail to remain open while projector is in operation, remove taper pin in slot, stretch spring to give it more tensions, and replace.

TO OPERATE.—The douser may be operated by hand whenever desired. The hand operation of one douser will in no way affect the other. To operate electricall, push button of switch and release IMMEDIATELY.



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